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THE RAMAPO WATER SUPPLY CONTRACT, which so nearly passed the Board of Public Improvements of New York city on Aug. 16, seems to have been effectually knocked in the head for the present. At the hearing held by the Board on Aug. 30 to give the opponents of the scheme an opportunity to express their views, a resolution was passed declaring the proposed contract with the Ramapo Water Co. to be against the public interests. The brunt of the battle against carrying out the contract was borne by City Comptroller Bird S. Coler and his colleagues, who after a hot fight at the meeting of Aug. 16, secured a postponement of definite action for two weeks in order to allow those who opposed the plan a reasonable time for conducting investigations and collecting evidence to support their objections. Briefly summarized, Comptroller Coler's arguments against carrying out the proposed contract were, that the company was a secret and irresponsible organization, and that it wouldn't have an asset until it got the contract from the city; that the city could furnish any additional water it needed at about one-third the cost of the Ramapo contract, and that the city had ample funds to do this work without encroaching upon the debt limit and without hindering any other great public improvement. He declared it to be his calm judgment that next spring the city would have a limit for issuing bonds amounting to at least $65,000,000. Following Mr. Coler, reports were presented by Mr. Geo. S. Rice, M. Am. Soc. C. E., Mr. J. J. R. Croes, M. Am. Soc. C. E., and Mr. Eugene F. McLean, Engineer of the Finance Department, New York city, against carrying out the contract. Mr. Rice, who had examined the watersheds of the company in Ulster and Greene counties, showed that only seven out of the 16 reservoirs which the company intended to construct were within the terms of the contract—i. e., 300 ft. above tidewater. These reservoirs would only hold twelve billion gallons, which in a dry season would furnish the city 200,000,000 gallons only for two months. Mr. Croes, in investigating the various sources of water supply, demonstrated that the city could furnish 200,000,000 gallons itself at a yearly cost of $1,416,016, against $5,162,500 under the Ramapo contract. Mr. McLean demonstrated by a series of percentages that in 1904 the city would have an excess of 100,387,000 gallons a day, instead of facing a water famine, as was predicted. All three engineers agreed that it would be five years before the Ramapo company could furnish the city a gallon of water, while the city in half that time could get an additional supply from the Ten Mile River. According to the reports of the hearing given by the daily papers the promotors of the contract in the Board of Public Improvements confined themselves to a defense of the purity of their motives in urging the consummation of the contract, but did not attempt to reply to the figures and statements presented by the Comptroller and his expert engineers.

THE FORFEITING OF CONTRACTS for work on the Chicago Drainage Canal is threatened by the Trustees of the Sanitary District, on the ground that the contractors are not making sufficient progress. The work in question includes McArthur Bros., contract for work at the Campbell Ave. eight-track bridge; Heidmaier & Neu's contract on Section N; Hayes Bros.' contract at the river end of the work, and Gahan & Brynes' contract on the tailrace and other work at Joliet. The Trustees propose to cancel the contracts and have the work completed under the direction of the Chief Engineer, Mr. Randolph, who is said to estimate the value of the contracts at $690,000. He has also reported that at the present rate of progress some of these contracts would not be completed before March or April of next year, while the Trustees want all work completed by December. The engineer says it can be done, but the contractors deny this.

DEFECTIVE CONCRETE IN THE DAM of the Chicago Sanitary District at Jackson St., Joliet, Ill., will necessitate the practical reconstruction of the dam. The defective work was due to the use of a poor quality of cement, but the work was passed by an inspector representing the Sanitary District, who has since been indicted and has confessed to having made false reports to the Chief Engineer. The dam is being built by the Sanitary District, but will be turned over to the State Canal Commission when completed, according to the decision rendered some time ago by the courts in the controversy between the Commission and the Trustees of the District. An examination was made on behalf of the Commission by Mr. G. W. Vaughn, M. Am. Soc. C. E., and Mr. E. C. Shankland, M. Am. Soc. C. E., and their report condemned all the work in which a certain brand of cement was used.

THE DUMPING OF DREDGED MATERIAL within eight miles from shore has been forbidden by the Health Commissioner and the Public Works Commissioner of Chicago, on the ground that it causes a pollution of the city's water supply. The contractors claim that this step is not legal, since the present dumping grounds were approved by the federal government and the city authorities. They also claim that they cannot afford to tow the material to such a distance. Major W. L. Marshall, U. S. A., in charge of the U. S. Engineer Office, at Chicago, has protested against the action, and claims that the material to be dredged from the harbor, the Calumet River and the banks of the Chicago River is clean and can cause no pollution, while the dredging of the foul material from the bottom of the river has been completed. He has threatened to recommend the stoppage of appropriations for dredging the Chicago River, but the city holds to its position.

THE BREAK IN THE HENNEPIN CANAL, recently reported in our columns, turns out to be less serious than was expected. It will probably involve a change in the alinement, but this will not materially affect the length or cost of the canal, though it will necessitate the abandonment of some work done and some right of way already purchased. The contractors encountered a bed of peat or decomposed vegetable matter, and stopped work, with the result that various rumors were circulated. This deposit was reported as loam or sound material in all soundings, but it has no mineral constitutents whatever. The work can be carried through it, similar material having been encountered on the North Sea Canal, in Germany, but it may prove better to avoid it.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Chicago & Eastern Illinois R. R. at Rossville, Ill., on Aug. 31. A freight train ran into some cars standing on the main track and was wrecked. Three men were killed.

A BOILER EXPLOSION in a bar mill of the Republic Iron Works, Pittsburg, Pa., on Sept. 1, wrecked the mill and caused the death of five men and the fatal injury of three others. The cause of the explosion has not yet been determined.

A NEW OCEAN RECORD, from Southampton to New York, has been made by the North German Lloyd steamship "Wilhelm der Grosse," which arrived at Sandy Hook on Sept. 5. The run was made in 5 d. 18 h. 5 m., thus breaking the previous record of 5 d. 20 h. made by the same ship in 1898. The distance covered in the last run was 3,049 knots, and the daily runs were 411, 546, 556, 538, 452 knots, with an average for the voyage of 22.08 knots per hour.

THE NEW BATTLESHIP "KEARSARGE" had her builder's trial on Sept. 5 under the disadvantage of a year's marine growth on her hull. The contract speed is 16 knots; but under forced draft she made 17¼ knots for one-half hour. The battleship made a complete turn in 2¼ minutes. The builders believe that when cleaned she will make 18 knots. Her official trial will take place after she has been docked at New York and her secondary battery is installed.

THE NAVAL ESTIMATES for next year aggregate $18,000,000, or $5,000,000 more than any previous annual estimate for "Increase of the Navy." There are now under construction 54 warships of all classes, including 11 battleships, 4 monitors, 3 armored cruisers, 6 protected cruisers, 33 destroyers and torpedo boats, and several miscellaneous craft. Two new dry-docks will be recommended by Admiral Endicott, Chief of the Bureau of Yards and Docks; one at New York and the other at Norfolk; both will be of granite and concrete, and they will cost about $1,250,000 each. It is also probable that the Secretary will recommend the building of three more protected cruisers, at $1,250,000 each, as recommended last year and rejected by Congress.

THORITE, the new high explosive adapted for the bursting charge of shells fired from ordinary guns, is made on a formula known only to its inventor, Dr. H. P. Tuttle, of Tacoma, Wash., and to a few army officers. In a recent test to determine the fragmenting power of thorite, it is reported that a 7-in. 132-lb. shell was loaded with 4 lbs. of thorite and then exploded by electricity in a 10-ft. square steel enclosure. It was estimated that the fragments numbered 20,000. Thorite-charged 10-in. shells have been fired through a 4½-in. Harveyized steel plate without exploding; and Dr. Tuttle is said to have plunged a red-hot poker into a 2-lb. can of it without perceptible result; in other words, it can only be exploded by the proper detonator.

A 12-IN. ISHAM SHELL, carrying 129½ lbs. of explosive gelatine, and weighing 1,000 lbs., was successfully fired at a 12-in. Harveyized steel armor plate at Sandy Hook on Aug. 23. It was fired from an ordinary 12-in. seacoast defence gun, but with a reduced charge, so that its striking energy was equivalent to that of a full service charge at a two-mile range. The plate was backed with oak beams and 20 ft. of sand and it was set at an angle of 45° to the line of fire. The detonation of the shell was imperfect; but the armor was dented about 2 ins., and it was blown through its oak backing and a corner of the sand pile, 17 ft. from where it had been set up. This shell is the invention of Willard S. Isham, C. E., of Vermont.

A CABLEWAY FOR COALING VESSELS AT SEA has been designed by the Lidgerwood Mfg. Co. The plans have been approved by a board of naval officers, and the Department has sent the collier "Marcellus" to the New York navy yard to be equipped with the device under the direction of Constructor Bowles. A sea trial of the device will probably be made in about 30 days.

WOOD FLOUR IN DYNAMITE, as a substitute for infusorial earth, is being tested in Saxony, says Consul-General Mason, of Berlin. The infusorial earth comes from one source, at Luneberg, between Hamburg and Hanover, and it is becoming scarce and expensive. The wood flour is regarded as distinctly inferior to the earth, and is only used when extreme cheapness of product is desirable in the manufacture of dynamite.

THE PACIFIC MAIL LINE has contracted with the Newport News Shipbuilding Co. for two new passenger and freight steamships, of 18,500 tons each. According to press accounts, these ships will be each 550 ft. long, have a speed of 18 knots, and cost about $2,000,000 each. They will be the largest ships of any character ever turned out of an American shipyard.

LAKE FREIGHT RATES, says the New York "Times," are higher now than since 1893. The following table is given showing the rates per unit, on Aug. 31, for the years 1893-99, inclusive:

Year.	Duluth. Ore.	Escanaba. Ore.	Dul. Wheat.	Chi. Corn.	Dul. Coal.	Chi. Coal.
1899....	$1.70	$1.25	$0.04¾	$0.03	$0.90	$0.90
1898....	.50	.40	.01⅞	.01⅜	.30	.20
1897....	.60	.40	.02	.02	.20	.20
1896....	.50	.40	.01⅞	.01¼	.20	.20
1895....	1.00	.65	.03½	.01¾	.50	.30
1894....	.80	.45	.02½	.01¼	.50	.30
1893....	.50	.40	.02¾	.01¼	.30	.20

The ore rates, particularly, show the extent of the advance. Though our contemporary does not say so, these rates are doubtless between Buffalo and Cleveland and the points named at the head of the columns.

CIVIL SERVICE EXAMINATIONS for positions in the Department of Public Improvements of New York city will be held as follows: Sept. 15, transitman and computer; Sept. 20, chainman and rodman. Lee Philips, Secretary Municipal Civil Service Commission, New York city.

THE NEW BUILDING LAW for New York city has been completed and submitted to the Municipal Assembly for consideration by the Building Code Commission appointed early this year. The new code contains 164 sections. Part I. defines the ordinance and its construction; Part II. provides for filing plans and statements; Part III., general definitions; Part IV., quality and tests of materials; Part V., excavations and foundations and the bearing capacity of soil; Part VI. deals with the erection of walls, piers, and partitions; Part VII. regulates the construction of apartment houses of certain heights. We expect to give more complete details of the engineering features of the new code in a future issue.

A NOVEL METHOD OF BRIDGE ERECTION; CONNECTICUT RIVER BRIDGE, NORTHFIELD, MASS.

The accompanying cuts show a curious, although not an entirely new method of erecting a bridge without falseworks, which was recently adopted in constructing a highway bridge across the Connecticut River, near the town of Northfield, Mass. This method of erection was adopted as it was necessary to erect the bridge at a time of the year when the river was full of ice and spring freshets were likely to move it before the bridge was completed. Besides this, the river bottom for about one-half the channel span was bare rock with a considerable slope, with water about 30 ft. deep, so that it would have been difficult and expensive to have used falsework. The contractors for the superstructure and erection were the New Jersey Steel & Iron Co., of Trenton, N. J., and the engineer appointed by the County Commissioners to design the bridge and take charge of its construction was Mr. Edward S. Shaw, of Boston. We are indebted to the contractors for the information from which this description of the erection has been prepared. Mr. J. W. Carrier was Resident Engineer, and Mr. J. J. Blake was foreman of the work for the contractors.

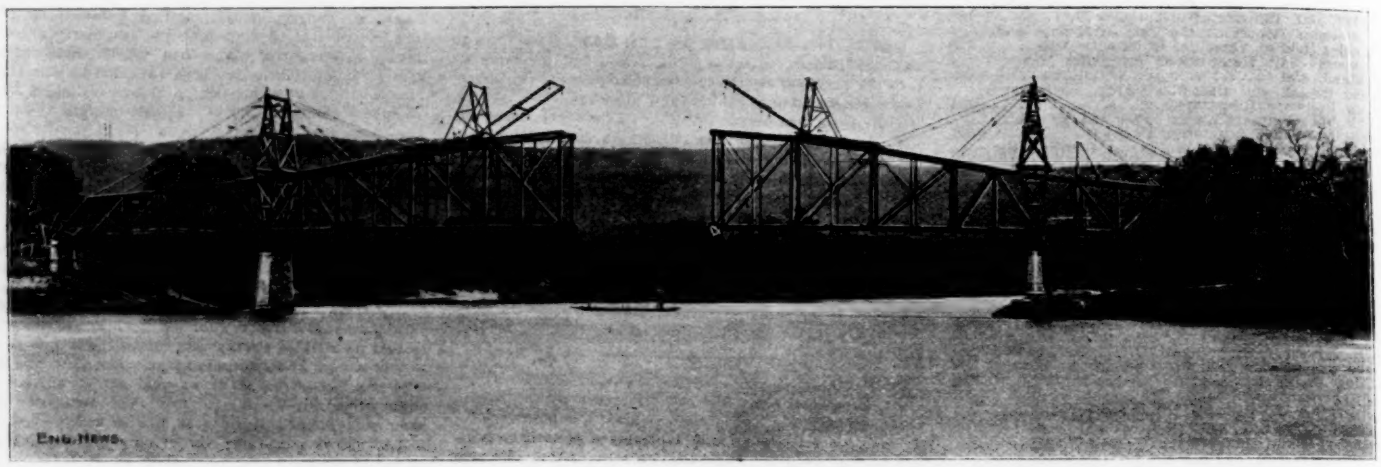

FIG. 1.—CONNECTICUT RIVER HIGHWAY BRIDGE AT NORTHFIELD, MASS., IN PROCESS OF ERECTION WITHOUT FALSEWORKS.
New Jersey Steel & Iron Co., Trenton, N. J., Contractors for Superstructure and Erection.
Edward S. Shaw, Boston, Mass., Chief Engineer.

The bridge is a continuous girder in form only, there being slip joints in the bottom chords at each of the panel points, L 4. All connections except the slip joints are riveted, and no joints are milled. Expansion is provided for by roller nests on each of the cylinder piers and by 12-in. rockers on one only of the two channel piers. Each shore span was erected on falsework, then loaded with sand to balance the half of the channel span which was erected as a cantilever. The towers and rods were used for erection purposes only, and served to reduce the strains in the bridge to allowable limits.

The general instructions for erection were as follows:

The end spans will be erected on falsework, and the channel span without falsework. The strut V 6, L 6, will be inserted after the channel span is swung. During erection of the tower, lines will be run from the points marked W to V 4 and U 8, and the foot of the tower will be lashed to the bottom chord; these lines will not be removed till after the rods b and b′ are in place. The end span is loaded as figured just sufficient to balance the half of the channel span. A factor of safety is provided by anchoring L 0 to the cylinders, and by an additional load of sand. Guy lines will be run from L 10 to the shore to prevent revolution in a horizontal plane.

First anchor L 0 to the cylinders, and fill sand boxes No. 2. After that erect the panels L 6, L 10. Move the traveler to the position shown by dotted lines, and put in place the rods b and b′. After that fill the sand boxes No. 3. After that erect the panels L 10, L 12. Move the traveler and put in place the rods a and a′. After that fill the sand boxes No. 1. After that erect the panels L 12, L 14. First fill sand boxes No. 4, and then load the short span with enough additional sand to prevent any strain upon the rods at L 0, during the erection of panels L 14, L 16. The rods a, b, a′, b′, will not be slackened until after the channel span is connected and self-sustaining, and the load of sand is removed. No part of the load of sand on the shore spans will be removed until after the channel span is connected and self-sustaining.

The half of the bridge resting on the 12-in. rockers was erected 3 ins. nearer the shore than its final position, and the center connection was made by drawing the parts together with four 2-in. turnbuckles. Two men worked one turnbuckle, easily at first and with greater effort afterward, on account of the pinching of entering connection plates.

Considering the true elevations to be the elevations marked in the drawings from which the bridge was made, the cylinder ends of the bridge were set about 1 in. below the true elevation, and with the cylinder ends in this position when the erection reached the center of the bridge, the center sagged to 7⅝ ins. below its true elevation. Each half of the bridge was then tilted by lowering the cylinder ends 4 ins., which raised the center of the bridge 5 13-16 ins., or within 1 13-16 ins. of the true elevation, and the bridge was drawn together and connected in this position. When the center connection was made, no trouble was occasioned by the ends of any one of the chords projecting beyond the others; the connecting members fitting so exactly that all the rivets for the center connections of the bottom chords were driven without any reaming or gouging, reaming being required for only three or four of the rivet holes at each of the center connections of the top chord.

After the load of sand was removed and the cylinder ends of the bridge were brought to their true position, the center of the bridge sagged slightly below its true elevation. This sag did no harm, as it simply changed somewhat the curve of the top and bottom chords from that shown on the drawings. The bridge was not cambered by lengthening or shortening any of the web members, and therefore would have sagged below what has been called its true elevation even if erected on falsework. Each 36-ft. section of the channel span was riveted before the next section was erected, except that the lateral bracing was bolted and was not riveted until after the center connection was made, in view of the possibility of the

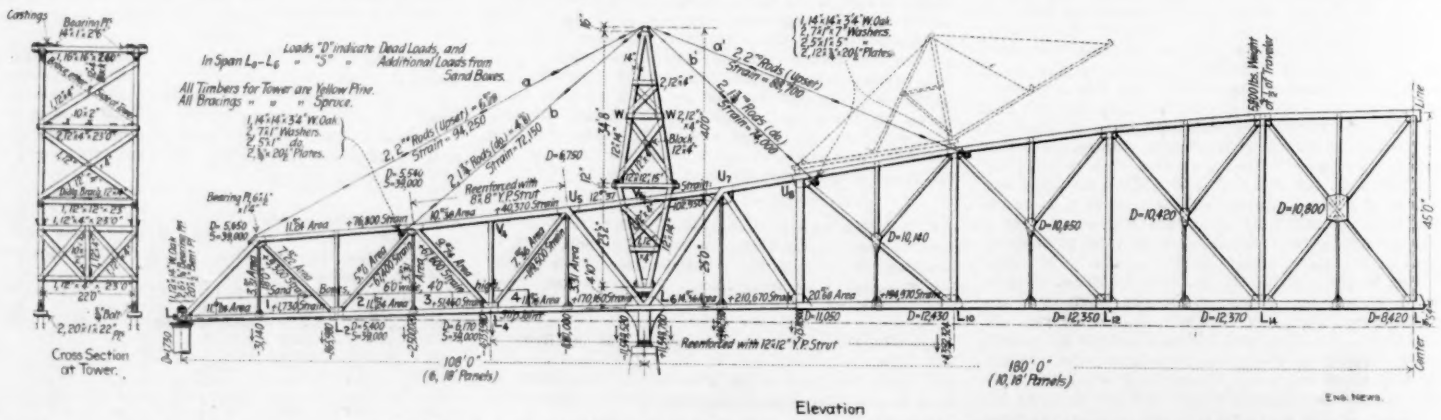
Loads "D" indicate Dead Loads, and
In Span L0–L6 = "S" = Additional Loads from Sand Boxes.
All Timbers for Tower are Yellow Pine.
All Brakings " " " Spruce.
Cross Section at Tower.
Elevation
108'0" (6, 18' Panels)
180'0" (10, 18' Panels)
Reenforced with 12"12" Y.P. Strut
Reenforced with 8"8" Y.P. Strut
Eng. News.

FIG. 2.—HALF ELEVATION OF CONNECTICUT RIVER BRIDGE AT NORTHFIELD, MASS., ILLUSTRATING METHOD OF ERECTION WITHOUT FALSEWORKS.

The towers and rods were used for erection purposes only, and served to reduce the strains in the bridge to allowable limits.

The general instructions for erection were as follows:

between any of these shoe plates and their bearings. That the pressure, when each half of the bridge was tilted, was distributed over the bearings on the channel piers as evenly as has been indicated, was due to the elasticity of the bridge. Had the bridge been perfectly rigid, all the pressure, when each half of the bridge was tilted, would have been on the shore ends of these bearings; and lowering the cylinder ends of the bridge

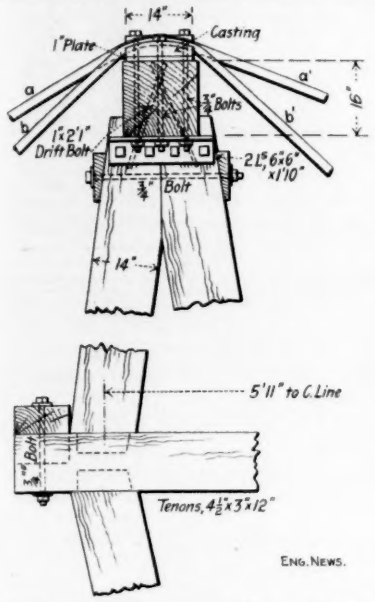

Fig. 3.—Details of Temporary Timber Tower Used in Erecting Connecticut River Bridge at Northfield, Mass.

4 ins. would have raised the center of the bridge 6 11-16 ins., instead of 5 13-16 ins. The elasticity of the bridge was further shown by the fact that guy lines run from panel points L 10 to the shore easily moved the projecting ends of the channel span in either direction without moving the cylinder ends of the bridge.

It might seem that the sag of the projecting ends of the channel span would make such an overhang of the top chords, the top chords being extended and the bottom chords being compressed, as would necessitate raising the center of the bridge to or above its true elevation before the center connection could be made. That it was possible to make this connection with a sag of 1 13-16 ins. at the center of the bridge was due in part to the pull of the tower rods, which tended to compress the top chords of the channel span, and in part to the sag at the center of the shore span from the load of sand, which tended to draw the top chords of the projecting ends of the channel span toward the shore. The bottom chord of the channel span after the center connection was made, but while yet in compression, measured 5/8-in. less than the length as given on the drawings from which the bridge was made. After the load of sand was removed and this chord was in tension from its own weight, it measured slightly more than when in compression.

One of the problems of this method of erection was to make each of the sixteen lines of tower rods and each of the four top chords, U 5, U 7, take its due share of the strain. An initial strain was given the 1¾-in. rods by four men turning the sleeve nuts as far as possible with a rope attached to the handle of a wrench with a 37-in. lever arm. An initial strain was given the 2-in. rods by using the engine to pull the rope, the same number of turns of the rope about the "nigger-head" being used to turn one sleeve nut on each line of rods. After the initial tightening, each set of rods was tightened but once, the engine being used for this purpose.

Measurements which were taken showed that the stretch of each of the four top chords, U 5, U 7, was quite uniform, and the same was true of the tower rods of the same diameter. The stretch in the chord, U 5, U 7, was a flush 3-16-in. in 33 ft. 4 ins., indicating a strain of about 16,000 lbs. per sq. in., which is greater than that shown on the drawing, while the strain in the rods was less than the assumed strain of 15,000 lbs. per sq. in., being somewhat less for the 1¾-in. than for the 2-in. rods. The strains might have been made nearer the calculated strains by another tightening of the rods, but this was not considered necessary.

As a means of determining whether the calculations for the weight of sand required were correct and that a sufficient weight had been placed on the shore spans, the shore ends of these spans were anchored by bolts passing from a wooden beam to the cylinder piers with about ⅛-in. space between the bolts and their bearings, so that if at any time, as the erection progressed, the weight of the channel arm was too heavy for the load placed upon the shore span to balance it, this ⅛-in. would have been taken up and the weight of the cylinder piers brought into play until such time as more load could be placed on the shore span. This, however, did not occur at any time.

The illustrations, and particularly the line drawing, Fig. 2, show many of the minor details of the erection not explained above. It will be noticed from Fig. 1 that the projecting ends of the channel span, being so much longer than the shore spans, presented a rather bold appearance during erection, but beyond alarming a few of the natives, no trouble was experienced from this cause.

PORTABLE PHOTOMETER AS USED IN THE STANDARD OIL COMPANY'S TEST.

In our issue of June 15, 1899, we described an interesting lamp test conducted by the Standard Oil Co. in New York to determine what lamp they should use for their annual supply of some 20,000 lamps. The photometer used in this test is such an interesting and unique type that we take pleasure in submitting to our readers some views and descriptions of the same, furnished by courtesy of the manufacturers.

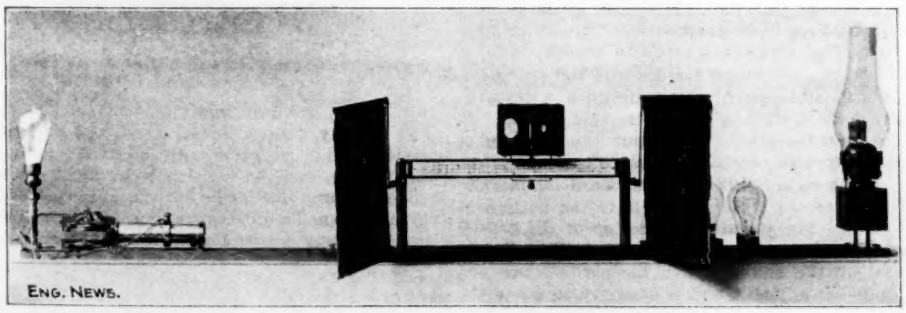

FIG. 1.—PORTABLE PHOTOMETER SET UP FOR USE.

The instrument in operating order is illustrated in Fig. 1. It is of the regular Bunsen grease-spot type, the spot box sliding back and forth on two brass rods, and the pointer indicating on the white celluloid scale the direct reading in candle power. The connections are shown at the left side of the instrument, and provide for attachment to the line, volt-meter, watt-meter or ammeter. A small german silver resistance coil with slider provides suitable means for adjusting the voltage.

The working standard of this photometer consists of a double burner kerosene oil lamp, shown on the right of the instrument. This is not a primary standard of itself, but is set to the correct brightness by means of a standard incandescent lamp placed at the opposite end of the photometer. Standard incandescent lamps form most accurate and reliable primary standards. They are made of any approximate voltage, the exact standardizing voltage being marked to tenths of a volt. Such lamps are seasoned low-efficiency lamps, which, as they are used for only a few minutes at a time, suffer no appreciable change. The oil lamp, or the working standard, is standardized by checking it with three standard photometer incandescent lamps provided with the outfit and held in the dummy socket, shown on the right. It is to be specially noted that the primary standard always occupies the same position as the lamp to be tested; therefore, tests can be accurately made with this instrument even though the room be not entirely darkened. The oil lamp is provided with adjustable screens that cut off the edges of the flames where flickering is apt to occur. The lamp is designed so that the flames burn low, thus insuring a steady standard of light that will remain constant for hours at a time without adjustment. Screens are arranged, as shown, to protect the eyes of the operator from the lights.

This oil lamp standard was adopted after extensive experimenting had proved it to be thoroughly reliable. It is extremely convenient and satisfactory, as it gives a constant, steady light, independent of the fluctuations of the voltage.

At the left of the instrument, shown more clearly in Fig. 2, is a small electric motor, which is attached by pulleys and cord to the rotating lamp socket. By means of this the lamp can be rotated at the rate of 180 turns per minute, thus enabling measurements of the mean horizontal intensity to be made at one reading. Results obtained in this way agree very closely with those obtained by taking the average of a great many separate readings in the horizontal plane, and can be secured, of course, with much less labor. This device makes easy the hitherto tedious work of finding the mean horizontal candle-power of a lamp. We would suggest that the machine could be provided with a rotary socket which could be set at any angle of inclination, thus making it easy to get the mean illumination in the corresponding zone in the same manner. In this way the mean spherical intensity could be arrived at.

The instrument telescopes and packs up compactly in a space of 24 × 6 × 9 ins. It is furnished with a canvas packing case, in which it may be kept protected when not in use or readily transported from place to place, as it weighs only 12 lbs.

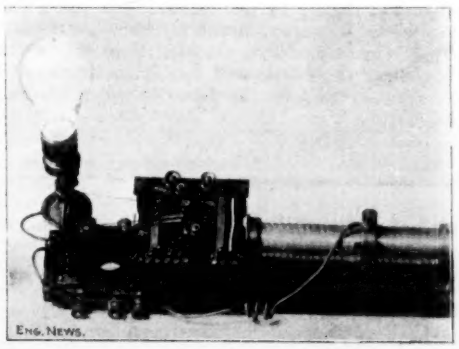

Fig. 2.—Standard Oil Lamp, Rotary Lamp Socket, Motor and German-Silver Resistance.

THE ELEVATOR SHAFT IN THE WASHINGTON monument, at Washington, D. C., is being overhauled, owing to some slight tendency to buckle in the diagonals of the elevator shaft framing, under the varying pressures to which the monument is subjected. These diagonals were originally rods, four to each 10 ft. of height. These rods are now being converted into compression members, or stiffened by being enclosed in a channel section and flat bar, drawn together by heavy bolts. The elevator shaft is perfectly safe, but the additional precaution was deemed advisable.

SOME IRRIGATION APPLIANCES IN THE SAN BERNARDINO VALLEY, CAL.

In an advance publication of the Division of Hydrography, of the U. S. Geological Survey, relating to the measurement of streams in the United States, we find some notes that are interesting to irrigation engineers in connection with irrigation practice in the San Bernardino Valley, California.

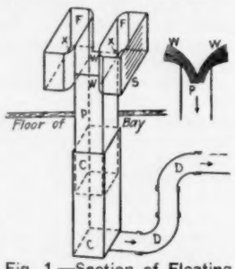

Fig. 1.—Section of Floating Weir for Measuring Irrigation Water.
W. T. Lambie, Los Angeles, Cal., Inventor.

The first of these, Fig. 1, is a floating weir, patented by Mr. W. T. Lambie, of Los Angeles, Cal., for dividing water among irrigators. This apparatus is designed to measure water, by uniform flow, from lakes, reservoirs, rivers, ditches, etc., under all conditions of fluctuation of surface. The device is simple in form, cheaply constructed, and may be made of wood or metal, or both combined. It can be gaged for the flow desired and the top locked. Machines are now in use with capacities varying from one to 1,000 miner's inches, and some of them have worked satisfactorily for about five years.

The device consists essentially of a fixed lower box, C, connected with the discharge pipe, D, which latter need not have the two quarter turns unless the water is deep and the floating pipe a long one. Into this fixed pipe slips a floating pipe, P, which slides through a collar tight enough to prevent any appreciable escape of water, and yet so loose that friction does not interfere with its free movement. This pipe, P, is steadied by passing through a floor in a bay, and is supported at the top by two floats, F. In these floats are placed weights sufficient to submerge the pipe, P, in accordance with a scale, S, marked on the outside of the floats; and this scale is graduated to show by its lines the depth to which the weir, W, must be submerged to measure a required quantity of water. A bellows attachment was at first tried for the bottom of the pipe, P, but it was found that silt deposits in the folds made the weighting of the floats uncertain.

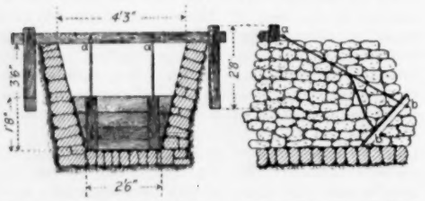

Fig. 5.—Stop for Diversion, with a Velocity of 4 to 8 ft. Per Second.

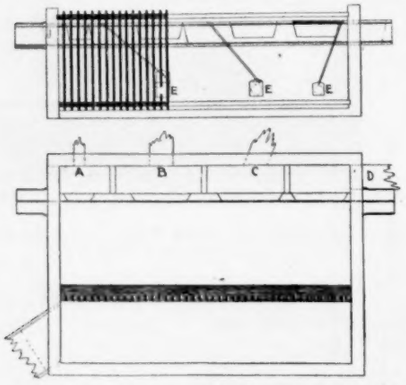

Fig. 2.—Measuring Box, with Cippoleti Weirs, Redland Canal.

On the Redlands Canal, at Redlands, Cal., there is a measuring box (Fig. 2) through which a considerable part of the water in the canal is measured out to various users. The water from the canal enters through a 36-in. cement pipe, a bay made of concrete and 18 ft. long, 12½ ft. wide and 5 ft. deep. In this bay is a screen for catching floating debris and breaking the motion of the water. After passing this screen the water flows over a series of weirs and then into conduits A, B, C and D, leading to the separate water companies. At E, iron gates are placed in the bottom of the bay, and these are used to turn on additional water when this is desired by any consumer. The weirs in this box are of the form designed by Cezare Cippoletti, for the Villoresi Canal of the Italian government. The sides, or ends, of these weirs are inclined outward on a slope of 4 on 1, or an angle of 14° with the vertical. By this arrangement the effective length of the weir is constantly equal to the length of the base, irrespective of the head of water. One side of each of these weirs is movable, so that it can be set at any given length of base; and, as the sills of the weirs are all on the same level the amount received by each claimant must be proportional to the length of his weir. These weirs are all made of thin plate iron set in concrete; and this division of water is reported as highly satisfactory.

In the Alessandro distribution system, the conduit system of vitrified cement, steel pipe, flumes and ditches aggregates over 75 miles in length, and covers 10,000 acres of land, with delivery at the highest point of each 10-acre tract. Where water is delivered under pressure and has to be measured, some device is needed for stilling the jet before the water passes over the weir. To meet these conditions, Mr. James Black, of Redlands, Cal., designed the measuring box shown in Fig. 3. The water is discharged from the 4-in. pipe against the end of the box away from the weir and it passes through openings, 4 ins. wide, in the top, and in the bottom of two bulkheads; it thus enters a third compartment at the bottom and passes quietly over the measuring weir. It is a simple and satisfactory arrangement.

The Bear Valley Co. uses several simple stop devices in canals to temporarily increase the height of the water for division purposes, and flow over weirs leading to laterals. Fig. 4 is employed when the velocity is low and flashboards can be handled. It is practically a frame, lowered in vertical grooves, and enough flashboards are inserted to raise the water to the desired height. When the velocity reaches 4 to 8 ft. per second, the gate is held, as shown in Fig. 5, by two 1-in. rods, which are hinged at a to a fixed cross-beam, and are rigid at b. When the canal is normal the gate is lifted entirely out of the water; and when water is to be diverted it is dropped in the canal, and acts as an inclined weir, the weight of the passing water holding it in position. In canals of high velocity, Fig. 6 is employed; and a heavy wire or chain, a, is substituted for the iron rod. A lever, b, is also attached to this gate with a rope, C, fastened to it. When not in use this stop lies on the bank of the canal. When put into the canal it floats at first, but by pulling on the cord the lower end of the gate is given a downward inclination, and the passing water forces it to the bottom of the canal. The elevation of the top of the gate is fixed by pulling on the cord, which is then tied to a post on the bank. When the cord is loosened the gate again floats, and is easily removed to the bank.

On the Santa Ana Canal, there is a combination wood and iron flume, of which a section is shown in Fig. 7. It is made of 1¾-in. redwood staves, about 6 ins. wide, and it is circular on the bottom with vertical sides 12 ins. deep to the 120 sec. ft. capacity. The flume is 5½ ft. wide in the clear, at the top, and about 3 ft. 3 ins. deep at the center. It is supported every 8 ft. by a T-iron bent to the shape of the outside of the flume, and prevented from spreading by a wooden yoke on top. The T-iron rests on a wooden sill cut to fit it, and this sill is supported by three concrete blocks molded on the solid rock of the flume bench. When there is no rock, mudsills of California redwood are used, as this wood has valuable lasting qualities in contact with earth. Between every two T-irons there are also two ⅝-in. iron rods bent to the shape of the outside of the flume, and passing through wooden cross-pieces above. On tangents the staves are 16 ft. long, and 8 ft. on curves; the minimum radius is 65 ft.

This flume has many advantages over the ordinary square wooden flume; but it also has weak points, developed by time and adverse conditions.

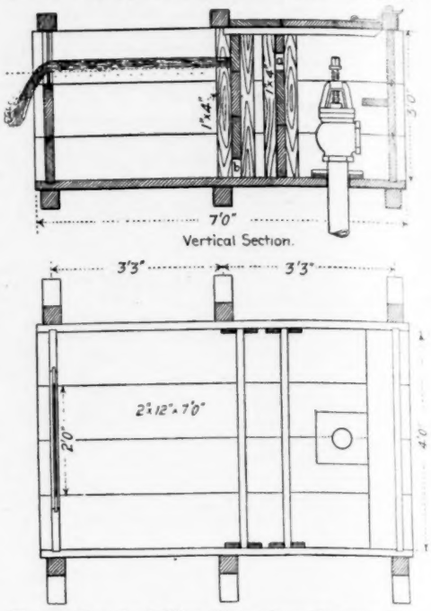

Fig. 3.—Box for Stilling Water from Pressure Pipe, Before Measuring Over a Weir.

The great advantage is that there is not a single nail in the flume proper; it can be tightened by screwing up the nuts on the ⅝-in. rods; and while the shape might be improved by making it semicircular, it is a good shape, and gives a large hydraulic radius. There are few points of contact between wooden surfaces, and its life is thus extended. It has, however, many longitudinal joints and the liability to leak is increased; the butt joints, for every 8 ft. on curves, are all in the same vertical plane, and the flume is weak against a slide coming from the inside of the curve. There is great expansion and contraction in case the flume is alternately dry and wet, in what is practically a surface 10 ft. wide with 18 joints; and unless water can always be kept in the flume, great attention is required to keep it tight. The lumber used is of an unusual shape, every stave having a bead ⅛-in. diameter at the joint. There is difficulty in making a tight joint where the butts come together over the T-iron, without seriously inter-

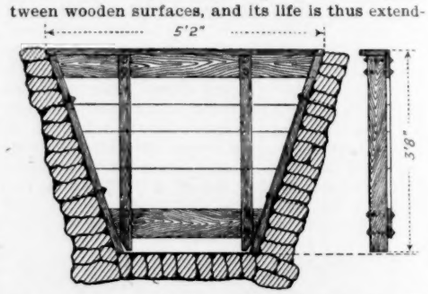

Fig. 4.—Stop for Diverting Water to Laterals; with Low Velocity of Flow.

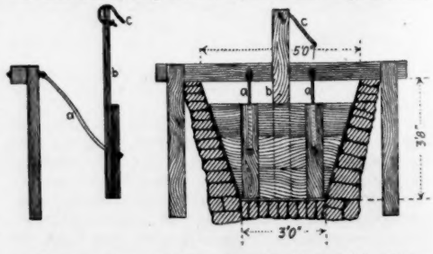

Fig. 6.—Stop for Canals with High Velocities.

fering with the flow of water; and in practice these joints are calked with oakum and plastered with asphalt, making a little ridge of asphalt

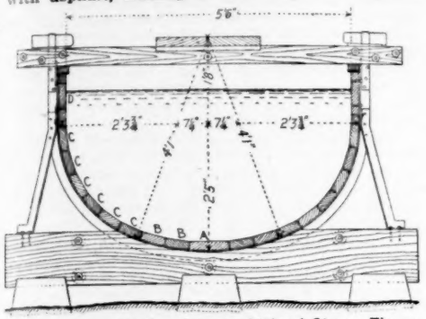

Fig. 7.—Combination Iron and Wood-Stave Flume, on the Santa Ana Canal.

around the flume at every joint. For depths of flow not exceeding 15 ins. this lessens the calculated carrying capacity 36%.

COMMISSION'S REPORT ON THE TEST OF HEAVY MOTOR VEHICLES, HELD AT VERSAILLES, IN OCTOBER, 1898.

Following the trials of August, 1897, the Automobile Club of France decided that tests of heavy motor vehicles should be held each year, under the auspices of the club, over the same course and under similar conditions. In accordance with this decision another meeting was held in October, 1898, and the commission in charge has just made an elaborate report. This report is published in full in "Le Genie Civil" for July 29, Aug. 5 and Aug. 12, with illustrations of the various vehicles taking part, and while the report in detail is bulky, it will be interesting to note the conclusions of the commission.

At the October meeting 19 vehicles were entered, furnished by 12 different manufacturers, one of them from England. The lengths of the three courses passed over were, respectively, 25.7, 28.8 and 41.2 miles, and the vehicles were divided into three main classes, as follows: No. 1, For the transport of passengers, operated by petroleum or steam; No. 2, For the transport of merchandise, operated by petroleum or steam; No. 3, Delivery wagons, carrying 2,200 lbs. and 1,100 lbs., with petroleum or electric motors. The purpose of the test was to compare cost of operation, speed, consumption of fuel, and general efficiency. The names of the various contesting manufacturers will be familiar to our readers, as their several vehicles have been described in this journal. In the tables presented the commission includes, not only the vehicles actually taking part in the October meeting, but also those of the same or analogous make which took part in the 1897 trials.

In the recapitulation which follows, column II. shows the quantity of fuel consumed per ton-mile by each vehicle. This column shows the relative economy of the utilization of petroleum over steam; but the corresponding column, referring to the relative cost of fuels, demonstrates the disastrous influence of the French duties upon petroleum and its derivations. It is also interesting to note the comparatively light expense of the electric motor, notwithstanding the considerable dead load which its use entails. In this connection the commission has set the cost of current at 0.225 francs per K-W. hour; because, although the net cost per kilowatt hour is only 0.15 fr., at the main charging station, it is 0.30 fr. at the charging stations along the line of travel.

The commission properly remarks that in figuring the net cost of transport per ton-mile, upon the actual cost of material, the length of the daily run plays a very important part; this transport will only be economical when the service is such as to permit the utilization of the full daily capacity of the machine.

As to the design of the vehicles themselves, the trials of 1898 showed a tendency among builders to increase the diameters of the motor wheels. Thus, the Serpollet omnibus had wheels 4.26 ft. diameter; the Roser-Mazurier omnibus, 3.92 ft. diameter; the omnibuses of Dion and Bouton, which had wheels of 3.28 ft. in 1897, in 1898 had increased this diameter to 3.61 ft. This tendency has its advantages on paved highways; but the widening of the tires of some of the makes is not so good, because of the tendency of the material of macadam roads to move in winter. The commission would prefer two sets of wheels; one with tires as narrow as the solidity of the wheel would permit, for summer use; and one with tires as wide as the compressibility of the roadway would demand, for winter use. In conclusion, the commission says that the trial of 1898 shows a notable advance over that of 1897; but it hopes that the meeting of October, 1899, will produce vehicles still better adapted for the transport of passengers and merchandise, both in regard to speed and economy of service.

In the accompanying tables, the French money and metric weights, etc., have been translated into English equivalents.

TABLE I.—Tests of Vehicles for Passenger Service.

Type of vehicle.	Year.	Cost.	Power of motor, HP.	Com'rcial speed, miles per hr.	Load—Useful, lbs.	Load—Dead, lbs.	Load—Total, lbs.	Total, pr HP. lbs.	Load on driv-ers, full load, lbs.	Ratio, load on drivers to full load.	Fuel per ton-mile.—Total, w't., lbs.	Fuel per ton-mile.—Pay'g load, lbs.
Steam:											—Coke—	
Omnibus Dion	1897.	$4,400	25.0	8.8	2,464	11,088	13,552	542	9,240	0.68	1.1	6.1
	1898.	4,400	30.0	8.9	4,400	14,036	18,436	614	11,440	.51	1.1	4.7
Pauline Dion	1897.	4,400	30.0	8.5	5,280	13,640	18,920	616	13,772	.73	1.2	4.2
	1898.	5,300	35.0	6.4	5,500	16,302	21,802	623	13,312	.61	1.3	5.0
Omnibus Serpollet	1898.	3,600	15.0	7.6	2,970	12,100	15,070	1,000	9,790	.65	Heavy oil.[1] .103	.504
Leyland Brake	1898.	2,000	6.0	5.9	1,650	4,290	5,940	990	3,443	.60	Petroleum.[1] .25	.45
Petroleum:												
Omnibus Panhard	1897.	3,600	12.0	7.8	2,200	5,280	7,480	623	5,060	.68	.062	.20
Delivery Panhard	1898.	2,400	8.0	8.8	2,200	4,950	7,150	894	4,510	.66	.046	.15
Dietrich Brake	1898.	2,400	8.0	7.1	2,200	4,510	6,710	745	4,444	.66	.057	.17
Omnibus Roser.	1898.	3,600	9.5*	6.0	2,090	5,940	8,030	845	4,356	.53	.033	.12
Electric:											Watt-hours.	
Delivery electric	1898.	2,600	3.5	6.2	1,650	4,554	6,204	1,773	3,960	.63	240	903
Delivery Krieger	1898.	3,000	8.0	6.3	1,100	3,366	4,466	558	2,233	.50	178	727

*Compound. [1]U. S. gallons.

TABLE II.—Net Cost at Station of Passenger Service.

Type of vehicle.	Year.	Miles per day.	Expenses independent of load.—Int. & sinking fund.	Expenses independent of load.—Person-nel.	Expenses independent of load.—Fuel oil.	Expenses independent of load.—Expense,—Gen-eral.	Expenses independent of load.—Expense,—Total.	Expenses varying with load.†—⅓ load.	Expenses varying with load.†—⅔ load.	Expenses varying with load.†—Full load.	Total expenses per day.—⅓ load.	Total expenses per day.—⅔ load.	Total expenses per day.—Full load.
Steam:													
Omnibus Dion	1897	90.0	$3.08	$2.20	$1.46	$0.67	$7.41	$2.18	$2.34	$2.50	$9.59	$9.75	$9.91
	1898	87.0	3.06	2.20	.68	.59	6.53	2.78	3.07	3.63	9.31	9.60	10.06
Pauline Dion	1897	67.0	3.71	3.20	1.22	.83	8.96	2.91	3.22	3.52	11.87	12.18	12.48
	1898	82.5	3.06	2.20	.68	.59	6.53	2.75	3.15	3.61	9.29	9.68	10.14
Leyland Brake	1898	56.0	1.40	1.60	.42	.34	3.76	2.31	2.55	2.85	6.07	6.31	6.61
Omnbs Serpollet	1898	74.4	2.52	1.60	.56	.47	5.15	6.92	7.86	8.48	12.07	13.01	13.58
	1898*	....	....	....	....	....	....	4.85	5.50	5.88	3.98	10.62	11.02
Petroleum:													
Panhard vehicle	1897	65.0	2.52	1.60	.70	.28	5.10	3.27	3.70	4.05	8.37	8.80	9.15
	1898	87.0	1.68	1.60	.20	.35	3.83	3.13	3.55	3.97	6.96	7.38	7.80
Dietrich Brake	1898	68.0	1.68	1.60	.30	.36	3.94	2.83	3.23	3.59	6.77	7.17	7.53
Omnibus Roser	1898	56.0	2.52	1.60	.35	.45	4.92	.50	1.01	1.52	5.42	5.93	6.44
Electric:													
Electric delivery	1898	59.0	1.82	1.60	.15	.35	3.92	1.48	1.65	1.80	5.40	5.57	5.72
Krieger delivery	1898	60.0	2.10	1.60	.15	.38	4.23	.80	.90	.97	5.03	5.13	5.20

*With oil at 0.15 franc per liter, or 11½ cts. per U. S. gallon.
†Energy consumed.

TABLE III.—Tests of Vehicles for the Transport of Merchandise.

Type of vehicle	Steam.—Dion.	Steam.—Scotte.*	Petroleum.—Dietrich.—	Petroleum.—Dietrich.—
Year	1898	1897	1897	1898
Cost	$3,800	$4,800	$1,200	$2,000
Power of motor, HP., metric	30	16	6.5	9
Commercial speed, miles	6.9	4.3	5.3	5.6
Load: Useful, lbs.	7,260	9,240	2,640	3,300
Dead, lbs.	12,188	16,610	2,860	4,114
Total, lbs.	19,448	25,815	5,500	7,414
Per HP. metric, lbs.	648	1,616	846	824
On drivers, full load, lbs.	11,748	12,606	3,960	5,379
Ratio, ld on drvrs to full ld	.60	.48	.72	.74
Fuel per ton-mile:	Coke, lbs.		Pet., U.S. gals	
Total	1.5	1.8	.048	.068
Paying load	3.9	5.0	.008	.152

*Trailer.

TABLE IV.—Cost of Merchandise Transport by Motor Vehicles.

Type of vehicle	Steam.—Dion.	Steam.—Scotte.	Petroleum.—Dietrich.—	Petroleum.—Dietrich.—
Year	1898.	1897.	1897.	1898.
Miles per day	66	43.4	55.8	62
Expenses independent of load:				
Int. & sinking fund	$2.66	$3.36	$0.84	$1.39
Personnel	2.20	3.20	1.60	1.60
Fuel and oil	.88	.97	.20	.30
General expenses	.58	.75	.26	.33
Total expenses	6.32	8.28	2.90	3.65
Expenses varying with load: ⅓ load	2.37	2.89	1.40	3.11
⅔ load	3.01	3.37	1.74	3.76
Full load	3.45	3.85	2.07	4.42
Total expenses per day:				
⅓ load	8.69	11.17	4.30	6.76
⅔ load	9.33	11.65	4.64	7.41
Full load	9.77	12.13	4.97	8.07

PROPOSED SALT WATER STREET SPRINKLING PLANT AT OAKLAND, CAL.

An interesting report on the use of salt water for street sprinkling at Oakland, Cal., has just been submitted to the city council by Mr. M. K. Miller, Superintendent of Streets. He estimates that an electric pumping plant with a capacity of 1,000 gallons a minute, a 384,000-gallon covered reservoir, 28.1 miles of 8, 6 and 4-in. vitrified clay pipe, and 329 goose neck wrought-iron hydrants, could be provided at a cost of $51,349.

The present street sprinkling service is rendered by 30 carts, drawing water from fire hydrants. The average capacity of the carts was 600 gallons, and the average number of loads distributed by each cart in a day of nine hours is 30, making 18,000 gallons per cart per day, and 540,000 gallons for the whole service. Each team and cart costs $4 a day, and the water used by it (26.7 cts. per 1,000 gallons), $4.80. The street sprinkling service extends over 128 working days, making the cost for the season $15,360 for labor and $18,640 for water, or $34,000 in all. The widths of the streets are not given, but it is stated that each cart covers from 7 to 14 miles of streets, averaging 9 miles.

An advantage claimed for the salt water is that one sprinkling with it "is equal in effect to three or four with fresh water." The city has a large mileage of macadam streets, which, during the dry season, must be sprinkled very frequently, as a mere matter of preservation, to say nothing of comfort. Mr. Miller thinks that with salt water 25 carts will easily take the place of the 30 now in use, while possibly water every second day will be sufficient, cutting in half the number required. He also urges that the saving in street repairs, owing to keeping the macadam well cemented, will be a large item, to which should be added a decrease in weed removal, the salt water killing the weeds in the gutters.

The proposed plan is designed to supply salt water for 20 carts, distributing 32 loads each per day of 9 hours, or a total of 384,000 gallons, equal to 711 gallons a minute, or 1.58 cu. ft. per sec. The 329 hydrants would be so located that empty carts will not often have to travel more than one block to be refilled. The hydrants would be 4-in. wrought-iron goose necks, provided with brass gate valves.

The reservoir is designed to provide storage for one day, which is thought to be sufficient, inasmuch as it is believed sprinkling may be suspended a day, or even more, without serious inconvenience. The yearly overhauling of the plant can be performed when sprinkling is not being done.

A 35-HP. electric motor is proposed to drive the pump, which, as stated, would have a capacity of

1,000 gallons a minute. The reservoir would be 40 × 100 ft., × 13 ft. deep, covered by a light roof. The elevation of the reservoir would be about 100 ft. above city datum, which would give sufficient head, Mr. Miller states, to fill carts from hydrants up to an elevation of 60 ft. Above this point a longer haul can be used for some of the carts, and the small remaining territory may be sprinkled, as now, with fresh water.

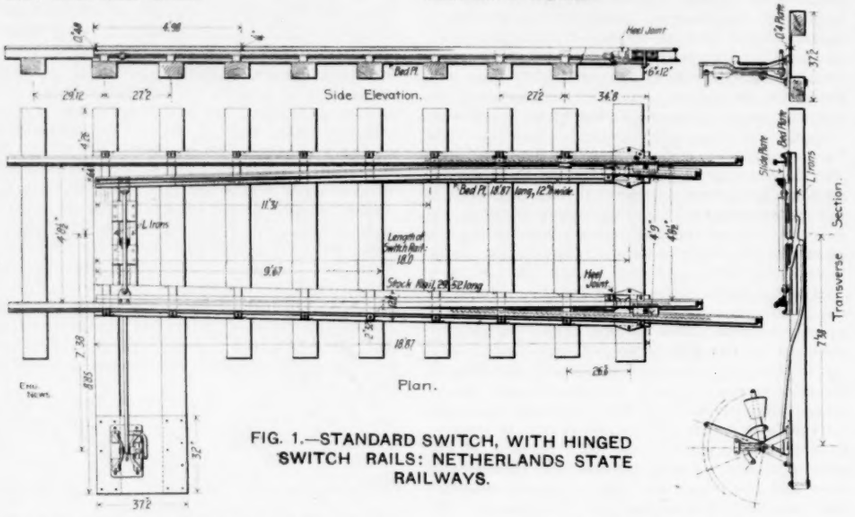

FIG. 1.—STANDARD SWITCH, WITH HINGED SWITCH RAILS: NETHERLANDS STATE RAILWAYS.

For distributing mains, vitrified pipe are considered as not only cheaper than iron, steel or wood, but probably much more lasting. The relative estimated costs of vitrified, copper wire bound, redwood stave, asphalt-coated, cast iron or steel, and cement-lined wrought-iron pipes are given in the accompanying table:

Relative Estimated Cost of Pipe of Various Materials for Distributing Salt Water.

Diam., pipe.	Lin. ft.	Vitrified.	Redwood.	Cast-iron.	Steel.	Cement-lined w. i.
8-in....	14,850	$5,198	$10,395	$16,335	$8,850	$8,850
6-in....	18,400	5,520	8,280	15,660	9,200	9,200
4-in....	115,300	23,060	28,825	69,180	46,120	46,120
Total..	148,550*	$33,778	$47,500	$101,175	$64,170	$64,170

*Or 28 miles.

The cost of the vitrified clay pipe in place was figured at 35, 30 and 20 cts. per lin. ft., respectively, for the 8, 6 and 4-in. sizes. The estimated cost of the hydrants was $24 each, or $7,896; reservoir, including land, fence and covering, $4,225; motor, pump, building and suction pipe, $2,950; making, with the $33,778 for vitrified pipe, a total of $51,349.

It has been stated that the cost of sprinkling this year, with fresh water, will be $34,000. The estimated annual charges for street sprinkling under the new plan, with 25 salt and 4 fresh water carts, is about $20,000, including 5% interest on the cost of the salt water system. In addition to the $14,000 of saving thus indicated, Mr. Miller figures that $3,000 will be saved on street repairs, $2,000 on street cleaning, and $300 on sewer flushing, making a total saving of about $19,000 a year.

In conclusion, we quote Mr. Miller's discussion of the relative merits of the different kinds of pipe for use in the salt water distributing system:

Considering the great efficiency of salt water as compared with fresh water for street sprinkling purposes, it is an extremely singular fact that not one of our sea-coast cities, either on the Atlantic or Pacific coast, has ever installed a complete salt water distributing system of pipes. Few, if any, reliable data on the use of pipe for this purpose are available; and it renders quite difficult of decision the all important question as to the kind of pipe which may best be used for this purpose.

Cast-iron and steel pipe dipped in asphaltum are now used almost exclusively for fresh water distributing mains but this kind of pipe will last but a short time for carrying salt water. Asphaltum is insoluble and theoretically it would appear that iron pipe once dipped in this material would be protected from the corrosive effect thereof, but in practice it is often impossible to obtain theoretical conditions. On a 12-ft. section of iron pipe, after being dipped in an asphaltic bath, there might be thousands of microscopic exposures of the iron. Examples of the corrosive effect of salt water upon iron pipe are numerous, and, considering this fact, the advisability of using either cast-iron or steel pipe for this system becomes at once very doubtful. Iron and steel pipe is also being seriously impaired and in some cases entirely destroyed by electrolysis and this trouble is becoming more serious every day in many cities. It is therefore desirable to find material for the distributing mains which is unaffected by acids or alkalis or electricity, and at the same time is possessed of the necessary strength to resist the hydraulic pressure which will be imposed.

Vitrified Iron Stone Pipe.

Vitrified salt-glazed iron stone pipe, commonly used for sewer purposes, is undoubtedly the best material which can be used for salt water conduits, provided it is built of extra strength to withstand the hydraulic pressure which will be imposed. This kind of pipe is less indestructible by natural elements; is less corrosive than any other kind of pipe; is unaffected by electricity, alkalis or acids, and can be constructed of sufficient strength to withstand a pressure of 100 lbs. per sq. in., and will be ample for this case. For this particular purpose the pipe for diameters of 6 and 8 ins. should be constructed in lengths of 3 ft. and without the usual bells or collars.

Various designs for tightening and strengthening the joints of the pipe can be gotten up, but it is believed that the most inexpensive and at the same time the most effective method will be simply to wrap the joints in burlap first dipped in hot asphalt. Joints of this kind have been tried and found to be remarkably efficient both in strength, tightness and durability. This kind of pipe is far less expensive than any other which can be used and all things considered is believed to be the best for this purpose.

Arrangements have been made for testing the pipe with various kinds of joints and, if the results prove as favorable as is anticipated, the question as to the best kind of pipe to be used is disposed of.

Wooden Pipe.

It is also practicable to use wooden pipe for this purpose. Pipe of this material is coming into quite general use throughout the world and particularly for large diameters, and its lasting qualities are equal in most cases to iron pipe. The best wooden pipe is constructed of redwood staves bound with steel bands or wound with copper wire. It can be built to sustain any desired pressure and for salt water distributing purposes would undoubtedly prove a success. The cost of this pipe is much less than iron, but some 40 per cent. higher than vitrified iron stone and when used for salt water distribution might be seriously damaged by the marine worms, teredo.

Sheet-Iron Cement-Lined Pipe.

Light sheet-iron, cement-lined pipe might also be used successfully for this system. To what extent the cement lining will protect the iron from the action of salt water is problematical. No data on this point are available. It would doubtless be of great assistance and if any kind of iron pipe is used, it is believed that a cement-lined pipe will prove the most lasting. The cement lining is more or less porous and it is extremely difficult to make free of imperfections and still more difficult to handle without cracking and abrading.

At the present moment, pending the result of further study on this most important question, it is respectfully recommended that the choice of kind of pipe to be used be in the order named as follows: (1) Vitrified iron stone pipe, (2) redwood stave pipe, (3) cement-lined sheet-iron pipe, (4) cast-iron pipe, (5) steel pipe.

Estimates of the cost of the vitrified iron stone mains with hydrants are given separately for various sections of the city, to make clear the relative cost of construction either for the whole or part of the system at one time. With a pumping plant and reservoir constructed, a pipe system can be extended to cover various sections of the city at the will of the city council.

HINGED SWITCH AND CAST STEEL FROG; NETHERLANDS STATE RAILWAYS.

Foreign practice in railway track work has many points of interest in comparison with American practice, and we illustrate herewith two specially interesting features of the track construction of the Netherlands State Railways Co., for drawings of which we are indebted to Mr. J. W. Post, Engineer of Permanent Way for that company, and inventor of the well-known Post steel tie (Eng. News, Aug. 25, 1898).

In Fig. 1 is shown the standard switch, with 18-ft. switch rails, which have pivot or hinge joints. In ordinary American practice a bolted fish-plate splice forms the hinge joint, but in this case it will be seen that a lug or pin in the base of the switch rail fits in a recess in a special heel casting, no splice connection being used. The throw of the toe of the switch is 6.4 ins., while the width over gage lines at the heel is 4.52 ins. The stock and switch rails rest on a pair of steel bed-plates, 18.87 ft. long and 12.8 ins. wide, these plates being notched for the spikes which hold them to the ties. All creeping is prevented by bolting the heel filler block through the bed-plate, behind the 6 × 12-in. switch timber which carries the heel hinge castings. Under the toe of the switch, the plates are connected by a pair of angle irons, with top batten plates, which thus rigidly maintain the gage. Only a single head-rod is used, and that is non-adjustable.

Figs. 2 and 3 show one of the standard crucible cast-steel frogs, which have been almost exclusively used for about 20 years past for rails of 51.2, 67.4 and 80 lbs. per yard. Cast-iron frogs, with chilled or case-hardened surfaces, have long ago been abandoned, and frogs built up of steel rails and forged steel points are used only for exceptional angles, to save the expense of special patterns for the steel castings.

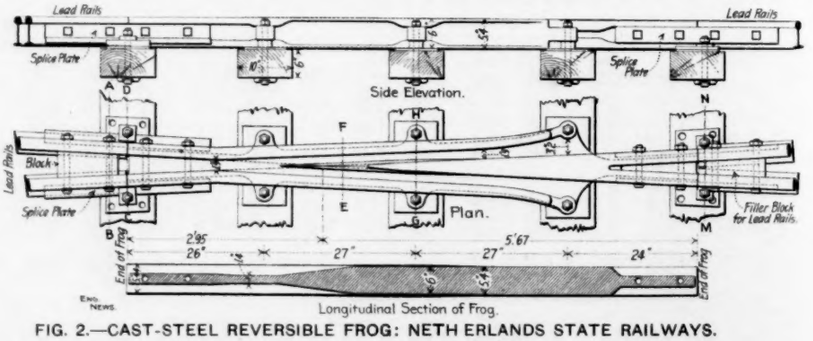

FIG. 2.—CAST-STEEL REVERSIBLE FROG: NETH ERLANDS STATE RAILWAYS.

The cast-steel frogs are reversible, and are considered the best as to wear and maintenance. In designing them, great care must be taken that the inclines, depths, etc., are exact, and that the shape is such as to render it possible to make a good casting. Long experience and practice are necessary to ensure the casting of these frogs to the exact shape, with smooth, hard surfaces, and free from flaws, blow holes and brittleness. The manufacturers guarantee them for five years against

defects on either side, but do not guarantee them for wear, as that is a function of the traffic.

The cuts illustrate a No. 10 frog, which is 8.62 ft. long, and has flangeways 1.9 ins wide, with the same width in the throat. The frog guard rails are spiked to the ties, and tap-bolted to the filler blocks in the flangeway. They are 11.87 ft. long, straight for 3.28 ft. at the middle, with a flangeway 1.76 ins. wide. They then flare out to a flangeway of 2.56 ins. in 3.28 ft., and are then curved for 0.75 ft. at one end and 1.28 ft. at the other, the end spacing being 6 ins.

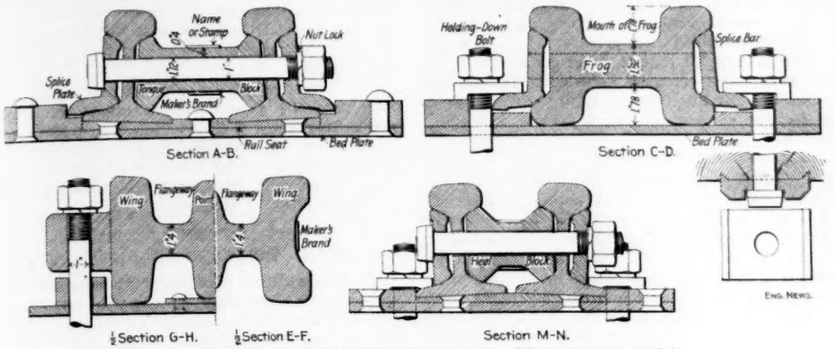

FIG. 3.—CROSS-SECTIONS OF CAST-STEEL REVERSIBLE FROG.

THE MOUNT WHITNEY WATER POWER ELECTRIC PLANT AND LIGHT REGULATING DEVICE.

The latest of the numerous Pacific coast plants for developing water power and generating and transmitting electric current for lighting and power purposes, is that of the Mount Whitney Power Co., Visalia (Tulare County), Cal. This company has bought out the Visalia Gas, Light & Heat Co. The new power plant has a capacity of 2,000 HP., and the company already has contracts amounting to 700 HP., as follows: 345 HP. in Visalia, 175 HP. in Lindsay, 90 HP. in Tulare, and 90 HP. in Porterville. The current is used for arc and incandescent lighting, driving irrigation pumps, and for general power. Mr. Wm. H. Hammond is President of the company; Mr. A. G. Wishon, Vice-President; Mr. Robert McF. Doble, Consulting Engineer; Mr. D. L. Wishon, Chief Engineer; and Mr. Donald H. Fry, Electrician.

The water is taken from the east fork of the Kaweah River (whose headwaters are on Mount Whitney), at Oak Flat, 45 miles from Visalia, and 2,500 ft. above sea level. A ledge of rock crossing the river forms a natural dam, and water from the pool or reservoir thus formed is led through a tunnel to the flume. This tunnel is 3 ft. high, 6 ft. wide and 47 ft. long. It is at right angles to the river, so that drift, etc., will be carried past its mouth. Beyond the tunnel are waste and regulating gates, so that only the desired amount of water will flow into the flume.

The flume is 30,000 ft. in length, with a grade of 0.5%. It is 3 ft. wide and 2 ft. deep, built of redwood planks, 1½ × 12 ins., with battens 1 × 4 ins. nailed over the seams. It rests on sills 4 × 4 ins., 4 ft. apart, to the ends of which are attached the side posts 2 × 4 ins., connected by caps 2 × 4 ins. Upon the caps is a 12-in. foot plank. A great many trestles were required to carry the flume over ravines, and these are built of redwood timbers 4 × 4 ins. Sand boxes and waste gates are provided at intervals. At the end of the flume is another sand box and an overflow gate, at right angles to which is the apron or entrance to the penstock. The mouth of the apron is 9 ft. wide, and is fitted with screens and gates. The penstock is 6 × 8 ft., 16 ft. deep, and both it and the apron are covered.

From the penstock a steel pipe line extends to the power house, 3,300 ft. distant, and 1,300 ft. below. It is laid mainly in a trench, the cost of excavating which was considerable, as it is cut through solid rock, and is 20 ft. deep in one place. The size of the pipe at the penstock is 50 ins., which diminished to 24 ins. in 50 ft., forming a funnel mouth. Below this are 2,140 ft. of riveted pipe and 1,160 ft. of welded pipe, the diameter decreasing gradually to 20 ins. at the discharge end. The sections of pipe were carried up to the trench by a cableway. As each section was riveted on, it was well tamped with earth and water, and then covered. The pipe line is anchored to the rock of the trench at intervals by bands and turnbuckles and cement collars, and for 400 ft. at the power-house end it is embedded in concrete. On the first 1,000 ft. of the pipe (from the top) there are six air valves. Within the power-house there are three branches, delivering water to as many wheels, while the end of the pipe serves as a waterway. The end is fitted with a gate and nozzle, the same as the branches, so that it may be used for testing the efficiency of the nozzles delivering water to the wheels. The pressure at the nozzles is 565 lbs. per sq. in., and the jets have a velocity of 17,000 ft. per minute. The pipe was made and laid by the Lacy Mfg. Co., of Los Angeles, Cal.

The power-house is on the south bank of the Kaweah River, 35 miles from Visalia, and is a corrugated iron building, 30 × 50 ft., with concrete foundations. The gates on the nozzles are of special design, on account of the great pressure, and are operated by hand wheels which actuate worm gearing. There are three 50-in. water wheels, each having 20 bronze brackets, and they weigh about 1,400 lbs. each. The water, which is deflected downward into the tail race by the regulating device, is delivered upon heavy cast-iron baffle-plates.

Each water wheel is directly connected to the shaft of a Westinghouse alternating-current dynamo of 450-KW. capacity. They are three-phase machines, separately excited, of the slotted type, with continuous wound armatures; 1,020 amperes, 440 volts, 7,200 alternations per minute. The shaft has the water wheel mounted on one end and a cast-steel flywheel weighing 4,000 lbs. on the other. The normal speed is 515 revolutions per minute. There are also two belt-driven, direct-current generators of 15-KW. each, 124 volts, running at 1,050 revolutions per minute. These are the exciters, and each one is of sufficient capacity to excite the three dynamos, and can be driven from either water-wheel. The switchboard has three dynamo panels, an exciter panel and a distribution panel.

There are four step-up transformers of 500-KW. capacity each, the fourth being held in reserve. They are oil-insulated transformers, with a primary voltage of 440, and a secondary voltage of 20,000 volts with delta connection, or 34,000 volts with Y connection. The secondary wires lead to the high-tension switches at the end of the power-house, and thence to the lightning arrester house, 12 × 12 ft., 25 ft. distant. Each of the three lightning arrester units consists of six choke coils in series with the line and 30 arresters mounted on a marble slab.

The transmission line consists of three medium copper wires, No. 2 B. & S. gage, one wire being carried on the tops of the poles and the others at the ends of Oregon pine cross-arms, 3 × 4 ins. Where the transmission line branches to Tulare and Portersville, the wires are reduced to No. 5 gage on each hand as far as Visalia and Lindsay, respectively, and thence to No. 6 gage at the terminals. The poles are of redwood, sawed to shape, 9 ins. square at the bottom and 5 ins. square at the top, where an iron band is placed to prevent splitting. They are 26 ft. high in the mountain district, 30 ft. high in the orchard district, and 35 to 40 ft. high at road crossings and in towns. The wires are attached to 7-in. triple petticoat glass insulators on eucalyptus pins, boiled in oil. About 30 ins. below the cross-arm for the transmission wires is a six-pin arm for the telephone wires of the Sunset Telephone Co. From the power-house the distance is 29 miles to Visalia, 40 miles to Tulare, and 43 miles to Porterville.

Substations are established at Visalia, Tulare, Exeter, Lindsay and Porterville, at each of which the three-phase high-voltage current is reduced by step-down transformers to a two-phase current of 2,000 volts for distribution for light and power purposes. The Visalia substation also contains a 30-light arc machine for street lighting, driven direct by a 20-HP. induction motor. The incandescent lighting circuits are supplied direct from the 2,000-volt distribution, the potential being reduced by transformers placed on the poles.

One of the specially interesting features of the plant is the use of a device for preventing consumers from burning too many lights. In electric lighting, the question as to the relative merits of flat rates and meter rates is a general one, and must be solved by each management to suit local conditions. In large cities and in the business districts of towns of medium size, it has practically ceased to be a problem, the electric meter being an assured fact under such conditions. The question is a serious one, however, in the case of scattered residence districts, where many small consumers are supplied. The outlay for line and transformers in such a district is large, and makes it desirable to avoid the cost of a small meter for each consumer and the expense of salary of at least one man to read meters, and perhaps another to keep them calibrated and in repair. These salaries and the interest on the first cost of the meters must come out of the consumers' pockets. On the other hand, many a possible consumer will refuse to pay a flat rate on lights for every room in his house. Unless he has a light in each room, however, he will be obliged to use oil, and the expense, care, dirt and risk of two oil lamps is not much less than for four lamps. He will therefore do without the electric light, if he cannot afford to pay a flat rate for lights in rooms that are seldom used. In conjunction with the flat-rate system, the Mount Whitney Power Co is using a small and cheap, but thoroughly reliable, electrical device for regulating the number of lights burned by each consumer.

It consumes practically no power (about ½-watt per lamp), and does not affect the lighting service as long as the rated number of lights (or less) are burned. The moment this number is exceeded, however, all the lights in the house begin to flicker, going on and off about 120 times a minute. It will not leave the house in darkness, as would a fuse device, but gives sufficient light for the consumer to find a switch or socket and to turn out a light or two. As soon as the excess lights are turned off, the rest will again burn steadily.

For example, a man has a ten-room house, and wants a light in each room, but refuses to pay a flat rate on ten lights, as he never burns more than seven at one time. With ten lights and with the regulating device attached, he can burn any seven lights at any one time, but when the eighth light is turned on, all the lights begin to flicker, and he will have to turn out one of the lights. If he finds that he requires the eight lights, the device can be adjusted for that number.

The principle upon which the device works is very simple. The moment the allowed current is exceeded, a solenoid overcomes the pull of an adjustable counterweight and periodically puts the lights on and out by means of a series and shunt coil and a make-and-break contact. The rapidity of the flickering can be adjusted. The whole thing is enclosed in a small tin box, sealed with a meter seal, and needs no attention whatever. It is the invention of Mr. M. Lacey, of Hanford, Cal., and it is said to be invaluable for flat rate service, the saving in transformer capacity alone being sufficient to pay for its introduction.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

The paper on the use of concentrates in the blast furnace, which is presented elsewhere in this issue, gives a very good summary of the experience in this field of the metallurgists of Scandinavia. In this country the very low cost at which the fine Mesaba ores have been delivered at furnaces has given a setback to magnetic concentration processes during the last half dozen years; but the present boom in the iron market will be likely to give them new courage. In general, we believe American operators of magnetic concentration plants have not crushed their ore very fine, being content to stand a little loss in the tailings rather than produce a material unsuitable for direct use in the furnace. As a consequence concentrates, when used with care, have given little trouble, we believe, in American blast furnaces. The only case of which we know where briquetting of the concentrate has been attempted is at Edison's famous works in New Jersey. Here very fine crushing is a necessity to extract the ore, and the final concentrate is far too fine for direct use in the furnaces. It is therefore made up into briquettes with rosin oil, and these, after baking, are ready for shipment to the furnaces.

Secretary of War Root proposes to stop further publication of the details of government tests of new explosives, projectiles, ordnance, etc.; and in so doing he simply follows the legal injunction of not exposing to your adversary—until the proper times comes—the material gathered for the support of your own case. Other nations carefully conceal what we have been accustomed to spread abroad, in voluminous and well-illustrated department reports and Congressional documents. It is even stated that a full list of our coast defences was published in the "Congressional Record" just after the outbreak of the Spanish-American war. This was just the material our enemy wanted, and our own War Department generously supplied them with it. Just now our military authorities are experimenting with a new explosive, to be used as a bursting charge of great destructive power in shells fired from an ordinary gun. If this thorite, as it is called, is all that is claimed for it, it would be a powerful addition to our military strength in case of any emergency; and it would be the reverse of wisdom to provide an enemy with a club which might be wielded to our disadvantage. A nation which possesses reserve strength and war material of a quantity unknown to its adversary, is in a stronger position than if all that it could command in an emergency were common knowledge throughout the world. For this latter reason, if for no other, the decision of Secretary Root is wise and commendable.

On another page will be found some tabular data covering an exhaustive series of tests of heavy motor vehicles, intended for use as omnibuses, for heavy trucking and for delivery-wagon service. These tests were made at Versailles, in 1898, by a commission appointed by the Automobile Club of France, and followed a similar trial held in 1897, and a third is appointed for October of this year; in all of these trials the courses gone over and the conditions to be fulfilled are alike. Upon the tabular results the commission has little to say, other than that progress has been made over the machines of 1897; and it contents itself with expressing the hope that still more economical and efficient motor machines may be produced at the coming trial.

An inspection of these tables show—what this journal has more than once remarked—that the thoroughly efficient, commercial motor-vehicle for heavy use, has yet to be designed; and while notable progress has been made with the lighter motor-machines, especially in this country, practically the same remark will apply to the latter type. These tables clearly show some of the grave difficulties yet to be overcome, and especially in the proportion of dead load to paying load, and in the total weight to be propelled. An 11-ton steam vehicle to carry 36 passengers, with little or no baggage, can hardly be called a successful motor-omnibus; and while the use of petroleum as fuel shows some advantages, the omnibuses of this class carry a lighter load, and still show about the same proportion of three to one, in dead and paying load. The electric motor, for delivery service, shows up well, notwithstanding its heavy proportionate dead load; in fact, in this respect it is no worse off than the average steam or petroleum motor. The total expenses of operation also seem high, for all classes; especially, when it is remembered that attendance and general expenses are figured on a French basis, with a lower range of wages, etc., than prevails in this country.

The fact is a notable one, however, that France is holding these tests, year after year, and is seemingly conducting them in an intelligent manner, and with the earnest desire to demonstrate the shortcomings of the new machines. This service is as useful to the inventors and makers of machines as it is to the general public, for it gives both an opportunity to know just what has been accomplished and what yet remains to be done. The same thing should be done in the United States. A visit to the Third Automobile Exposition, now being held in Paris, convinced the writer that in lightness, combined with strength, and in general grace of design, many of the American motor vehicles surpass the French models. But, beyond alluring advertisements in the public press, and the loud claims made by rival companies which have stock for sale, we know little of the comparative merits or real efficiency of the American machines. It is not a difficult task to design a machine which will propel itself and a considerable load over a fairly good road; but what the public really wants to know, both as a prospective user of machines and a possible purchaser of stock, is what it costs to perform this work under varying conditions of load and roadbed; what is the life and efficiency of the machine, and what are its advantages and disadvantages as compared with older methods of vehicle propulsion on common roads. The motor-vehicle, for this purpose, has undoubtedly come to stay, and in time the commercial machine will be developed and come into common use. But at the present time, as with all new devices, the motor-wagon is in the developmental stage; and a carefully conducted, intelligent competitive test is one of the quickest ways of helping on this development. For these reasons, it would be well for the progress of the art in the United States to have some such competitions as the French are now conducting; to fairly test the merits of all machines, and to make clear the features in which they are still lacking.

Road races have been held time and again; but have generally shown nothing except the astonishing frequency with which the machines can break down. What is needed is careful competitive trials made under direction of experts to determine just such practical facts as were brought out in the French trials.

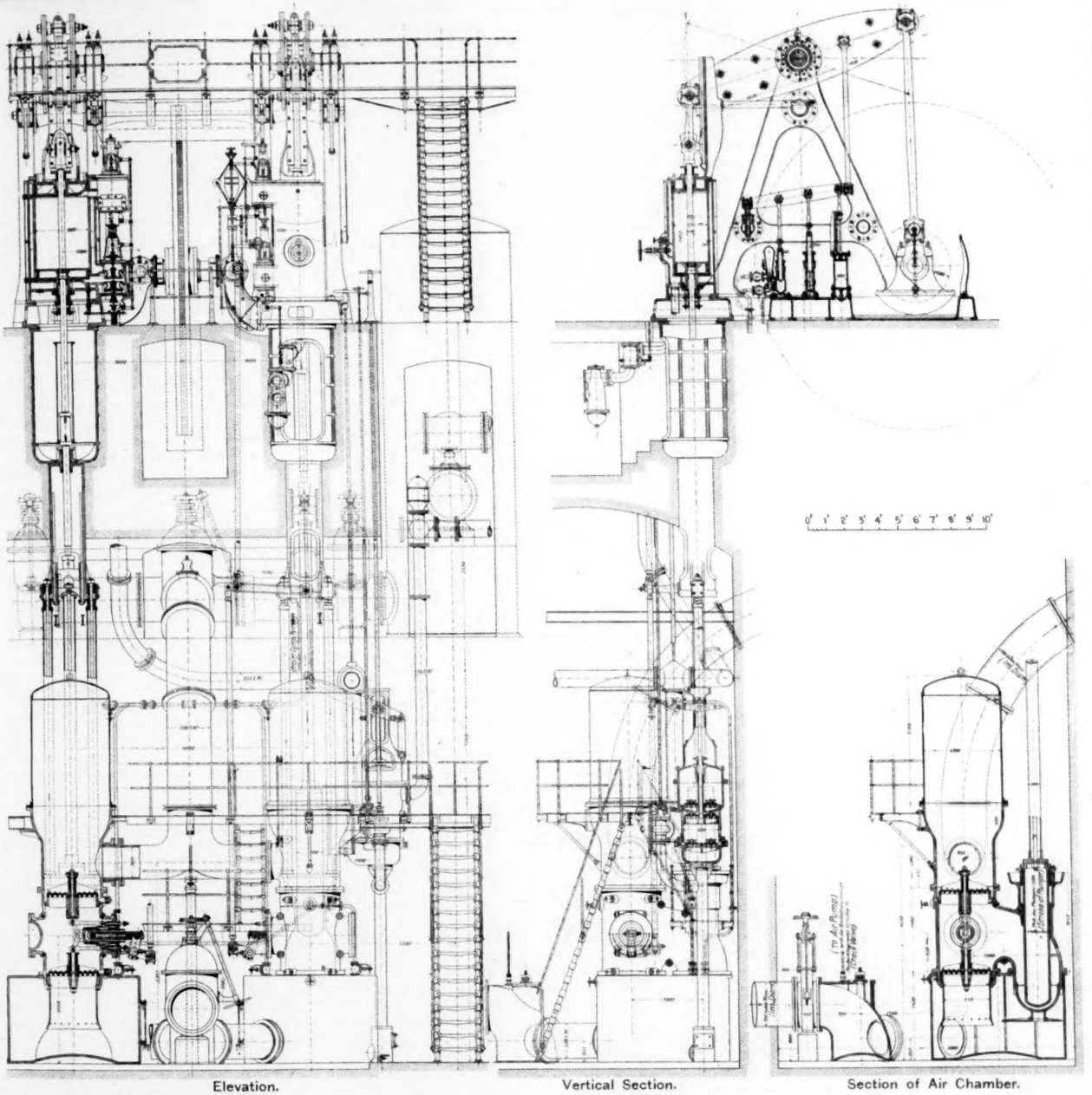
CONCERNING THE CASE OF CAPTAIN CARTER.

Practically all our readers, we presume, have become more or less familiar through the newspapers with the circumstances attending the charges against and court-martial of Capt. Oberlin M. Carter, Corps of Engineers, U. S. A. Thus far nothing concerning this case has appeared in this journal. At the outset it seemed to us that in a matter of such exceeding gravity, it was best to await the result of the judicial investigation, before giving space in these columns to accusations against a man who was at the least to be deemed innocent until proved guilty. We may say frankly, too, that when the charges were first made public, the editors of this journal were loth to give them the slightest credence. That an officer of the Corps of Engineers of Captain Carter's honorable record and high professional standing could be guilty of anything worse than possibly some technical irregularities in connection with the routine records and red tape, in connection with the work under his charge, seemed to us well-nigh unbelievable.

It is now just two years since these charges were first made known to the public. As our readers will remember, they followed close upon the appointment of Capt. Carter as a member of the old Walker Nicaragua Canal Commission. The condition of things on Capt. Carter's work at Savannah was reported to the Chief of Engineers on Aug. 14, 1897, by Capt. Cassius E. Gillette, who succeeded Capt. Carter in charge of the Savannah office; and on Sept. 13 a board of engineer officers, Cols. Gillespie and Raymond and Major Adams, was convened at Savannah to examine the works there and investigate the charges which had been preferred. The investigation of these officers was most thorough. Over a month was spent in the examination of witnesses, of the various papers and documents bearing on the case, and of the works themselves. The report of this board was such that Captain Carter was placed under arrest and a court-martial was ordered, and began its sessions at Savannah on Jan. 12, 1898.

Particular care was taken in the selection of the officers for this court-martial; the Judge-Advocate, Col. Thos. F. Barr, has been in the service for 34 years, and is a lawyer of eminence and marked ability. The President of the court-martial was Gen. E. S. Otis, now the head of the United States forces in the Philippines. Gen. Otis was educated as a lawyer and, notwithstanding some of the calumnies circulated concerning him in connection with his present responsibilities, is well known to be one of the most able and capable officers in the army. The Corps of Engineers was represented by Col. S. M. Mansfield and Major Wm. Stanton.

The main charge upon which the court-martial was held was that Captain Carter had entered into a conspiracy with members of the Atlantic Contracting Co., which had large contracts for jetty work, etc., on the Savannah River and in Cumberland Sound, by which he was given a share in the profits of these contracts, in consideration of his aid in securing the contracts to this company at a high figure and in permitting them to do such inferior work that their profits were exorbitant. The total amount of the fraudulent claims which were allowed and paid by the Government through Captain Carter's unfaithfulness was set at about $2,500,000.



Elevation. Vertical Section. Section of Air Chamber.

FIG. 3.—PUMPING ENGINE WITH RIEDLER VALVE GEAR.

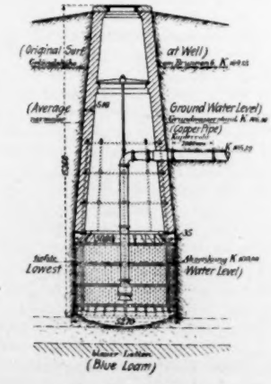


FIG. 2.—SECTION OF INFILTRA TION WELL.

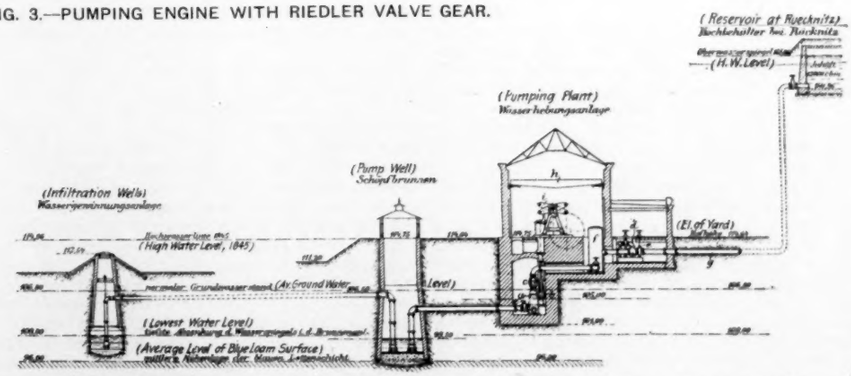


FIG. 1.—SECTIONAL ELEVATION OF WELLS, ENGINE-HOUSE AND RESERVOIR.

THE ADDITIONAL WATER SUPPLY OF DRESDEN, GERMANY.

Saxony Machine Works, Chemnitz, Contractors for Pumping Engines.

This court-martial continued from Jan. 12 to April 30, 1898, finally adjourning just at the outbreak of the Spanish war. In the length of its proceedings, it far outranked any other court-martial ever held in the United States. The whole record of Captain Carter's work at Savannah was gone over in the most painstaking manner by the prosecution; and the defense, conducted by four of the ablest attorneys in the country, presented its side in equal detail.

The report of the court-martial was forwarded to Washington on April 30, 1898, and while no formal statement of its contents has ever been made public, it has become known that Capt. Carter was found guilty on practically all the counts, was sentenced to dismissal from the army, a fine of $10,000, a term of five years in the penitentiary, and to have his disgrace and the circumstances of his crime publicly advertised in the newspapers at his home, while all officers of the army are to be forbidden to speak to him.

The record of this court-martial contained over 5,300 pages, or nearly 2,000,000 words; it was made up in 20 volumes of about 260 pages each, and besides this there were over 550 separate exhibits. It was, as the law requires, referred to the Judge-Advocate General of the Army for review, and he promptly transmitted it to the President with his approval of the findings. From here on the case begins to drag. Secretary Alger kept it pigeon-holed for some months. The papers were for a long time in the custody of the attorneys for Captain Carter. When they finally reached the President he asked ex-Senator Edmunds to review the case and give him an opinion upon it. This was done—at an expense of $5,000—and then the papers went to Attorney-General Griggs, in whose possession they still remain. He has recently announced that he is now waiting for Wayne MacVeagh, one of the attorneys for Capt. Carter, to return from a European tour and make an oral plea before him.

It may be remarked, parenthetically, that Mr. MacVeagh has already submitted, according to reports, three different formal briefs in this case before the President and the Attorney-General. When he returns and makes his oral plea—it will then be seen what further pretexts for delay may be found.

We have closely followed the course of this remarkable case from the outset. As stated near the beginning of this article, we earnestly hoped and confidently expected that Capt. Carter would succeed in wholly exonerating himself from the charges against him. He has not done so, however, and from all the study we have given to the evidence, we see no reason whatever to question the correctness and justice of the court-martial's decision.

It is not to present our own opinion as to Captain Carter's guilt or innocence, however, that this article is written. What we desire to do is to call attention to a few elementary facts, bearing directly upon this case, which seem at the present time to be in some danger of being overlooked.

The first of these is the extent to which FIDELITY TO TRUSTS has become absolutely necessary to the conduct of all our industry and to the very existence of our modern civilization. It was not so in anything like the present degree even a generation ago. Then industry and commerce were still largely in the hands of individuals and private firms, and the functions of government were comparatively few and unimportant. But now, in whatever field of human activity we look, we see men directing the course of great enterprises which are owned by others and controlling the expenditure of thousands and millions of dollars which belong to the nation, or state, or a municipal or private corporation. Each and every such man has it in his power to enrich himself by sacrificing, to a greater or less extent, the interests of which he is a trustee, and the only assurance the public can possibly have that the trust will be faithfully discharged is the honor and honesty of the officer on whom it is laid.

There is absolutely no getting away from this fact. Modern society stands face to face with it. You may change your system this way and that and the other; but in the end the public must trust somebody or other to carry out its work. Take for instance this very case of the Savannah harbor work. It has been said that it would be a gain to follow the English practice under which every seaport carries out its own works of harbor improvement. But whether that system is better or worse than the present one, it will be seen at once that under it the public would still have to entrust to municipal officials the responsibility for carrying out the work, and these officers in their turn must trust some engineer to do just the work that Captain Carter was set to do. Even if we take the position of the few who declaim against all governmental effort and would leave all such work to private enterprise, we are in the same or a worse position. If a private corporation, for instance, were given charge of Savannah harbor, not only would the people have to trust to that corporation to do its work properly, but the stockholders of the corporation would have to trust their directors, and they in turn their engineers and other officers to honestly carry out such works as it was desired to undertake.

We desire to emphasize this matter, because whenever such cases of dishonesty as this of Capt. Carter's, or the New York State Canal frauds, or the corruption in the Chicago sewer department—whenever the public hears of a public officer false to his trust, many unthinkingly say that it is a new argument against municipal or state or national control and management of public enterprises. Make no mistake. It is nothing of the sort. If great public works are carried on at all, somebody or other must be trusted to do it, and if the public turns over the responsibility to a private corporation, the only difference is that the bones may be picked pretty clean by the time the engineer gets a chance!

The point we especially desire to make clear, however, is just this: The vital necessity to the whole fabric of our civilization of absolute honesty and loyalty in the discharge of trusts, and the fact that we cannot possibly get clear of this necessity.

There are two enemies of the public welfare abroad to-day who strike a worse blow at civilization than the anarchist, and whose treason threatens the nation's existence more than that of the traitor in time of war. The first of these is the man who flouts honor and honesty and aims to get wealth by any means, fair or foul. It is such men as this that lay the temptation in the way of those in positions of trust. The second of these public enemies is the man who, being in a place of trust, yields to his temptation and enriches himself at the expense of those who have conferred upon him honors and responsibilities. What words are black enough to paint the depth of his crime?

Have we put the case too strongly? Consider where our civilization would be if all men or even the majority of men were like these. All governmental activity, all commerce, all industry rest upon the assumption that men are honest and will be faithful to their trusts. Without this every wheel would stop.

Fidelity to trusts! How can that lesson be impressed on every man who is placed in a position of responsibility? Do we not need to give every incentive possible to such men to keep them proof against temptation? Do we not need to add to their sense of honor, of high moral character, of upright integrity, that other incentive—the fear of punishment, swift, sure and severe, if they prove false?

Captain Carter's case has been sifted to the bottom before two tribunals of the highest character. He has had a full opportunity to prove his innocence and show clean hands as could be given him in any court in the land. The life, liberty and honor of any honest man are safer under the scrutiny of such a body of picked men as sat in his court-martial than before a jury in any civil court in the country. They spent four months in the most thorough search of every fact bearing upon the case, and we know of absolutely no reason for supposing that they did not do their duty without fear or favor.

Anyone, from the President down, who reviews the case at this day from its printed record can gain little insight into it compared with that of the men who gave their whole minds to it for four months, who heard the witnesses examined and cross-examined, who listened to the deathbed testimony of the assistant engineer who had served under the Captain, and to the examination of the Captain himself and of those not yet brought to trial who were alleged to be conspirators with him.

Here, as in everything else, the public must trust someone; and the body of officers which tried the Captain was better able to determine just where justice lay than any other man or men at Washington possibly can be.

We are not claiming, of course, that this court-martial was infallible. That can be claimed for no body of men. For neither the judge upon the bench or the jury in the box in a civil court. Sometimes courts-martial, like civil courts, are led astray by caste prejudices of one sort or another. There is not an iota of reason to suppose that anything of this sort influenced the decision in this case. Captain Carter is no Dreyfus; far from it. His friends all through the service and out of it were legion. His frank, open manner, and genial presence drew men to him everywhere. He appears to have had not a single enemy—save himself, and those who put temptation in his way. For this reason the task of those who have been faithful to their trust in this matter has been a very hard one. The influence, personal, social and political, which has gone into the defense of this case in Washington, New York and Savannah, has been without precedent. It gives one a feeling of pride and confidence in his fellowmen to find that in the face of all this the men who have been in charge of this case have been faithful in the discharge of their trust and unswerving in their determination to further the ends of justice.

There is, then, absolutely no reason why the verdict of this court-martial should not be carried into effect. If it is vital to the welfare of society that fidelity to trust should be secured, it is equally vital that falsity to trust shall receive punishment, swift and severe. Not on the criminal's account, of course. Captain Carter's punishment can be no possible gratification to anyone. It is the example to others that is the vital thing. It is essential to the safety of our institutions that when society does detect and prove the guilt of one who has been traitor to a trust, he shall then receive a punishment which shall warn every other man who may be subjected to like temptations.

It is, unfortunately, a fact that the crime of conspiracy too often escapes punishment. Collusion between a contractor and the engineer over him, between city officials and companies holding or seeking city franchises, between the officers of corporations and those with whom they do business—these are examples of the crimes of falsity to trust of which we are speaking, and it is well understood that proof of these crimes which will secure conviction in a civil court is exceedingly difficult to obtain: Our systems of civil law have been developed far more in the direction of shielding the one innocent man than of punishing the nine guilty ones. In far too many cases the impossibility of bringing direct evidence in proof of the charge of conspiracy and the doubt whether the average jury can appreciate the significance of circumstantial evidence compels the prosecuting officer to enter a "nolle pros," and a guilty man goes free.

It is fortunate that in this case there was other machinery than that of the civil courts to discover and determine the guilt of the offender. It would be a boon to society if every man accused of falsity to a trust could be tried before a body of educated and honorable men, competent to weigh and to appreciate the force of circumstantial evidence, and to unearth the real facts unhampered by the vast mass of legal technicalities which now hinder the administration of justice in our civil courts.

Society may yet see the time when the necessity will be forced upon it of providing better and surer means than the civil courts for the punishment of those who betray their trusts. No honest man would object to have accusations against him passed upon by a body of members of his own profession. Such men can understand a clean showing and a frank explanation of acts which may seem on their face to be indicative of guilt, as no ordinary jury can.

On the other hand, they can likewise weigh evi-

dence of guilt which would mean nothing to the average juryman, and can reach traitors who now escape to enjoy their ill-gotten gains and tempt others to like evil courses.

It has been said that the punishment awarded to Captain Carter is severe. It is mild in proportion to the offense. Society kills the man who commits a murder; yet the murderers to-day are no greater enemies to society than the men who are false to great trusts. Besides, the convicted man in this case has made no amends for his crime. If Captain Carter really wants to save a remnant of his honor he has one only chance. Let him return to his allegiance to the country whose welfare he swore to defend with his life, the country which educated him, bestowed upon him rank and honor, and clothed him with great responsibilities. Let him make a clean breast of his wrong doing and do everything in his power to aid in the punishment of those who led him astray. Then let him take his punishment like a man and a soldier. Men might yet honor him for such an action. Those who best know him personally agree, we believe, that it was the influence of stronger and more masterful minds that led astray this bright and talented young officer, who in the first years of his professional career appears to have led an upright and manly life and to have fully justified the high hopes of his many friends.

There is a concluding word, but space compels us to make it very brief. It is more than two years since knowledge of the frauds at Savannah became known to the authorities at Washington. During all that time not one step has been taken toward the punishment of those others who profited by the frauds at that place or the recovery from them of the stolen millions. They have had ample time to transfer all their property and make it impossible for the Government to recover a penny from them. Rumor says they have done this.

The query comes, then, who among the authorities at Washington has been false to his trust in this matter? Where was the pull exercised of these contractors who were (and could well afford to be) such liberal contributors to campaign funds? More information on this point is wanted, and the public is likely to get it even though it should take a Congressional investigation to drag it out.

LETTERS TO THE EDITOR.

Wheel Concentrations and Fatigue Formulas in Determining Bridge Stresses.

Sir: In your issue of July 13 there appears a letter from Mr. Henry S. Prichard, M. Am. Soc. C. E., in regard to the discussion before the American Society of Civil Engineers on the question, "Should the use of the method of wheel concentrations be discontinued in determining the stresses in railway bridges?" The writer fully indorses what Mr. Prichard says, and although he expected to take part in this discussion he was, at the time, not able to do so. In the first place, this so-called discussion was not a discussion at all, and "the members present did not vie with each other in poking fun at the old plan of specifying wheel loads." The fact is that there was no discussion, excepting that two or three members presented some method as a substitute for wheel loads, and two or three more members indorsed it. Beyond this, there was no discussion.

Instead of attempting to force the railroads to adopt a system of uniform live loads, in their specifications, which seems to the writer to be utterly hopeless, would it not be better to advocate the adoption of a series of typical locomotives? As Mr. Prichard says, "The calculation of the stresses produced by concentrated wheel loads, by proficient specialists, is a very simple matter." The difficulty, at present, is that there are so many different kinds of locomotives specified which produce practically the same results, and yet the computer is not permitted to equate these loads, but goes on making moment tables and moment diagrams ad infinitum. In answer to this, some one will probably say that this argument is in favor of a system of uniform loads, and so it would be, if the uniform loads represented the actual loading a bridge is subjected to. If the railroads can be induced to specify, say, five or six standard engine loads, the bridge companies and bridge engineers will take care of the rest, without complaining, provided they are familiar with the short methods of handling wheel loads.

At the time the question of wheel loads came before the convention at Cape May, the question, "Should the use of fatigue formulæ be continued," was also discussed. In all of the various discussions on this subject, as applied to bridge design, the writer has never seen any mention made of the element of time or the number of repetitions of loading in a given time. This element is of the highest importance in the consideration of any fatigue formula, and yet we go on using a formula based on Wohler's experiments, which apply to parts of machinery only, in which the loads are applied at regular intervals, a condition totally dissimilar to the loading of a bridge.

If the effects of live load are provided for by proper percentages for impact, no fatigue formulas are necessary.

Yours truly,
J. W. Schaub, M. Am. Soc. C. E.
1650 Monadnock Block, Chicago, Ill., Aug. 21, 1899.

Sugar Engineering at Tulane University.

Sir: In your issue of August 17, in noticing the small pamphlet issued by the engineering department of the Tulane University of Louisiana, you, by implication, take exception to the idea of "sugar engineering" having reached the dignity of a distinct branch of the profession. Will you allow me to say that in the experience of the sugar planters of Louisiana the "mechanical engineers" and "chemists" that "have made more or less of a specialty of sugar-making machinery and processes" do not exactly satisfy the demand for an all-around man, who is familiar with both the mechanical and chemical sides of the industry, and who is capable of taking intelligent general direction of a sugar-making plant. It is primarily with the object of supplying this need and of offering a suitable training for the sons of sugar planters that this course has been planned. It has been in operation but a few years, yet there are already distinct indications that it supplies "a long felt need."

On general principles there is no more objection to the idea or name of a course in "sugar engineering" than there is to the idea or name of a course in "electrical engineering," or "mining engineering," or "sanitary engineering"—all of which well-recognized departments were novel a few years back. The needs of the sugar industry are peculiar, and it is highly important that they be intelligently met by the technical schools. At the meeting in Boston of the Society for the Promotion of Engineering Education I called attention to the importance of the consideration of these needs by our American schools, in view of the recent large additions to our country of sugar-producing lands, and the prospective rapid increase in the domestic growth of sugar beets. Sugar making to be profitable must be carried on a scale and with an exactness that may well call for the direction of the skilled engineer. As was well pointed out by Prof. Johnson at the meeting referred to, and by Prof. Marburg, in your issue of August 24, we are distinctly behind Germany, for example, in "the specific training of our youth for industrial and commercial pursuits." In view of the enormous importance of the sugar industry, is it in any way objectionable to rank its intelligent direction among the departments of engineering, which is defined by Webster to be "the science and art of utilizing the forces and materials of nature?"

Very truly yours, Brown Ayres,
Dean, College of Technology, Tulane University.
Lexington, Virginia, Aug. 26, 1899.

(Our editorial note was merely intended to call attention to a new evidence of the tendency toward specialization in engineering education. There is generally agreement among technical educators, we believe, that such specialization is an excellent thing, provided it does not lead to the slighting of the foundation studies on which must be based any after work in special fields which an engineer may undertake, either in school or in after life.—Ed.)

ADDITIONAL WATER SUPPLY WORKS FOR DRESDEN, GERMANY.*

(With full-page plate.)

Owing to the growing needs of the city of Dresden it was found necessary some years ago to provide a supply of water much greater than could be obtained from the old pipe lines and viaduct, some of which dated back to the 16th century. After an extended examination of the available sources of supply it was finally decided to construct a pumping plant drawing water from infiltration wells, sunk along the banks of the river Elbe.

In the space between the pump-house and the Elbe are six of these wells, spread over a length of 400 m. (1,312.3 ft.) and placed 100 m. (328 ft.) apart. The water is drawn from them by a siphon which delivers it to a pump well at the pump-house. As may be seen from Fig. 1, the highest point in the siphon pipe is below the normal ground water level.

From the pump-well it is pumped either directly into the city mains or into a reservoir. The bottoms of the wells are on a clay shist and 12.75 m. (42.8 ft.) below the ground surface. The lower third of the well is lined with a perforated cast-iron cylinder 5 m. (16.4 ft.) in diameter and upon this rests a water-tight masonry lining which is carried to a height of 3 m. (9.8 ft.) above the original ground level where the opening, 1.5 m. in diam. is closed by a cast-iron cover. The assumed lowest water level is at elevation 100 m. (328.09 ft., which is 6.8 m. (22.3 ft.) below the normal ground water level and 11.34 m. (37.2 ft.) below the ground surface. The intake pipes reach below this level and connect with the main siphon. At each point where the pipes pass into solid masonry a length of copper pipe is provided to take care of any movements due to the settlement of the foundations. The pump-well is lined with masonry, and is also carried down to the clay shist. Indicators, placed so as to be in the plain view of the engine tender, show at all times the height of the water in this well. The highest suction point of the pump is at elevation 105.25 m. (345.3 ft.), the surface of the court about the pump-house, 114.64 m. (376.1 ft.), the engine floor, 114.75 m. (376.48 ft.), and the bottom of the reservoir, 160.86 m. (527.8 ft.).

The engines, which are cross-compound condensing with walking beams, are designed to deliver 20,000 cu. m. (706,310 cu. ft.) of water per 24 hrs., when running at 40 revs. per min., and with a boiler pressure of 120 lbs. The cylinders are 570 mm. (22.63 ins.), and 900 mm. (35.43 ins.) in diam., and the stroke is 1.2 m. (3.94 ft.).

The steam is distributed by a "Precision" valve gear, which can be adjusted by hand to give any desired cut-off, from 0 to 60%. A governor, driven from the valve-shaft, prevents the engines from racing in case of a sudden release of the load. The engines are provided with the following pumps: air, auxiliary feed, cold water, air suction and air compression. There are also a revolution counter, a manometer and a vacuum meter.

The pumps are mounted upon a vertical extension of the piston rods and have single-acting plungers. Since the two pumps feed into a common compression pipe and are connected 180° apart to the fly-wheel shaft, they act substantially as a single double-acting pump. The plungers are 440 mm. (17.32 ins.) in diam., and have a stroke of 1.2 m. (35.43 ins.). The Riedler valve gear is used, driven from the valve shaft of the engine. Below the suction valve of each pump is a suction air-chamber, and above the pressure valve a pressure air-chamber. The delivery pipes from each pair of pumps unite in a common pressure pipe, which is also provided with two large pressure air-chambers, each 2 m. in diam., and 6 m. in height, from which the mains lead to the city and the reservoir. The suction and compression air pump before mentioned are used to regulate the quantity of air in the different air chambers. Many difficulties were encountered in constructing the pump pit, which is 29.5 m. (96.8 ft.) long, 5 m. (16.4 ft.) wide and 12.25 m. (40.2 ft.) deep, reckoned from the engine floor. It is built entirely of well-tamped concrete. The floor is 1.5 m. (4.9 ft.) thick, and lies 5.8 m. (19 ft.) below the normal ground water level.

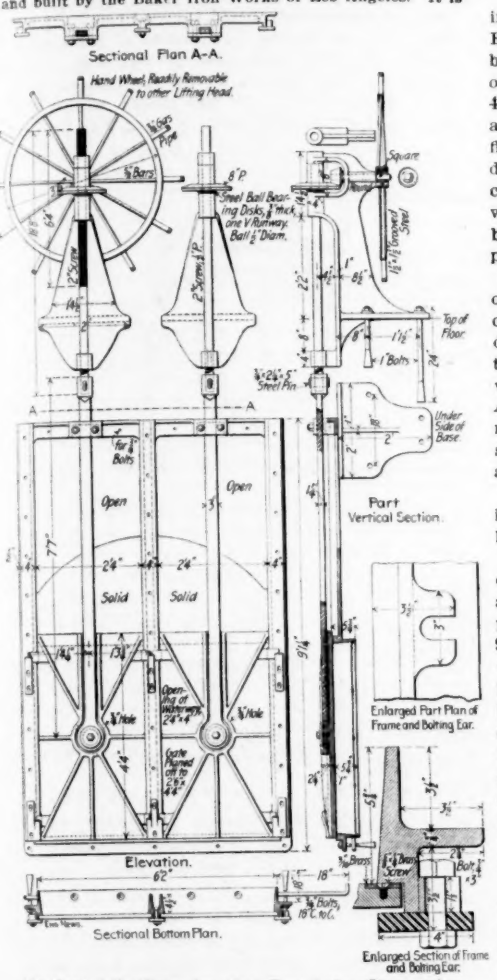
The engine house is 14.14 × 30 m. (46.4 × 98.4 ft.) in plan, and is designed to accommodate three engines like the one illustrated. An overhead crane of 20,000 kg. (44,000 lbs.) capacity is provided for the movement of heavy machinery. West of the engine house is the boiler house, with three boilers, one of which is for reserve. Room is provided for the addition of two more when necessary. The boilers are of the double-deck type, with two furnaces in the lower shell and 60 tubes in the upper shell. Each shell has its separate steam space and can be independently fed. The heating surface of each boiler is 162 sq. m. (1,528.5 sq. ft.) The fuel used is Bohemian liquite and heated air is supplied above the grates in addition to that which passes through them.

*Abstracted from a paper presented by Chief Engineer Vacherot before the Dresden Bezirksverein, Dec. 8, 1898, and published in "Zeitschrift des Vereines Deutscher Ingenieure," July 1, 1899.

TWIN GATES FOR THE FAY LAKE RESERVOIR, ARIZONA.

We are indebted to Mr. Jas. D. Schuyler, M. Am. Soc. C. E., M. Inst. C. E., of Los Angeles, Cal., for the accompanying illustration and description of a vertical lift, reservoir outlet gate, for the Fay Lake reservoir of the Farm & Fireside Co., of Northern Arizona. Mr. Schuyler writes us as follows:

The readers of the Engineering News may be interested in the enclosed prints of a vertical lift, reservoir outlet gate, designed by the writer for a reservoir in Arizona, and built by the Baker Iron Works of Los Angeles. It is



Vertical Lift Gate for the Fay Lake Reservoir.
Jas. D. Schuyler, M. Am. Soc. C. E., Engineer.

a simple design, but has some features of novelty to recommend it, and may offer some suggestions to engineers called upon to design similar gates. It is intended to be built into the face of a reservoir wall and close an outlet either rectangular or circular in form. The gate is hung on its center by one heavy lug, over which the stem is placed, expanded to the form of a flat eye-bolt, having sufficient play to enable the gate to accommodate itself to its seat freely, to which it is forced by inclined planes on six lugs and guides. The frame of the hoisting apparatus rests on top of the masonry to which it is anchored, and the nut and beveled gear are of hard brass. Ball bearings are fitted under the nut, and a light capstan wheel takes the place of the ordinary crank, rendering the gate easily handled under the maximum head of 25 ft. Having been urged to give this design to the profession the writer cheerfully contributes it to the News for what it may be worth, without claiming that it is specially worthy of notice; it is simply a good form of gate.

SEPTIC TANK AND SEWAGE FILTER BEDS FOR THE ESSEX CO LUNATIC ASYLUM, VERONA, N. J.

The largest septic tank for the treatment of sewage thus far built in this country is located in Verona, N. J., seven or eight miles from Newark. It receives the sewage of a branch of the Essex County Lunatic Asylum, and was designed and built by Mr. Jas. Owen, M. Am. Soc. C. E., County Engineer.

The tank and supplementary filter beds were put in operation about November, 1898, and now receive the sewage from a large building containing some 300 patients and attendants. Quite a large roof area is connected with the sewerage system, the connection having been made before it was decided to treat the sewage. The amount of sewage treated daily is placed by Mr. Owen at 40,000 gallons.

The tank is of concrete, 18 × 50 ft. × 10 ft. deep, giving a capacity of about 65,000 gallons. It has a trapped inlet, from a small grit chamber about 4 ft. square. There is a manhole at about the center of the top of the concrete roof of the tank, but the cover of this is sealed up with cement.

The tank effluent passes out through a pipe 16 ins. beneath the surface, onto four filter beds. Each bed is 14 ft. sq., with concrete walls and bottom. At the intersection of the division walls of the beds is a sheet iron distributing pan, 3 to 4 ft. in diameter, with a bottom curved upwards and a notch in one side to allow the sewage to flow onto the bed. The pan was provided with a device designed to cause it to revolve automatically through one-fourth of its circumference whenever the bed receiving sewage became filled, but the device has not proved successful, and the pan is now revolved by hand.

The filtering material was originally composed of sand at the top, then coke, then gravel, resting on a layer of large-sized stone, making a total depth of about 5 ft. This choked up in about three months of operation, which was in winter weather, making it difficult to do any cleaning. All the material, except the large stone, has been replaced by 3½ ft. of coke, with 6 ins. of coarse sand at the top. The walls of the bed extend about 16 ins. above the top of the sand.

The tank has not been cleaned since it was put in use. The amount of sludge which has accumulated is unknown, as the tank is sealed.

To the eye, the tank effluent, as it flows over the distributing pan, has a cloudy or slightly milky appearace, but seems to be pretty free from suspended matters. On the bed, however, a depth of 9 to 12 ins. has a brownish or yellowish look, like water standing in a muddy pool. A silver coin, held between the thumb and finger, could scarcely be distinguished at a depth of 5 or 6 ins. The tank effluent flowing from the pipe or dipped up in the hand from over the bed, had a strong sewage smell. One of the filter beds, which was in need of being raked, showed a thin skin of dark, almost black, sludge, which had curled up in small patches, on partially drying out. This, too, had a strong sewage smell.

The effluent from the filter beds is discharged into a ditch, leading to a small stream. This effluent at the point where it issued from the beds also had a pretty strong odor, less decided than that directly from the tank.

As the four beds have a combined area of only 784 sq. ft., they work at an average rate of more than 2,000,000 gallons per acre per day, assuming a total daily flow of 40,000 gallons. This is very high. With the present relation between daily flow and tank capacity, the sewage remains in the tank about 40 hours, assuming proper distribution through the tank, and making no allowance for sludge accumulation. Perhaps a shorter stay in the tank, or a more thorough aeration, or both, would enable the filter beds to do better work. As it is now, there is reason to believe that the sewage reaches the beds in such a state that little or no nitrification could be expected, except at a very low rate of filtration.

It is realized that the beds are overworked and a supplementary filtering area is proposed. The present plant cost about $2,600.

The above notes have been prepared by a member of the editorial staff of this journal, after two visits to the plant. We are indebted to Mr. Owen for information given and courtesies extended in connection with the preparation of this article.

A SMALL SEPTIC AND NITRIFICATION SEWAGE TREATMENT PLANT NEAR CHICAGO.

By Alvord & Shields.*

In March, 1898, after careful studies into the more recent English methods of bacterial purification of sewage had been made for the city of Columbus, O., and their trial then recommended, beginning on a small scale, an opportunity was afforded us to install a plant of this character for a large Golf and Polo Club House near Chicago.

The soil of this vicinity being a heavy clay, was not adapted to intermittent subsoil irrigation, which had already been ineffectually tried, and the expense of procuring sand, which had to be hauled from a great distance, debarred the consideration of artificial sand filters to any considerable extent. No dilution was afforded for the effluent, as the stream which passd through the grounds becomes entirely dry during the entire season when sewage purification would be needed.

The only available location was necessarily within full view of the club-house, and within 100 ft. of a teeing ground; so that it was important that the method adopted should be such as to enable the plant to be concealed from view.

Under these circumstances, nitrification on prepared coke beds was decided upon, and a first installation, based upon a sewage flow of 2,000 gallons per day, was installed in a little more than two weeks.

The plant consisted of a large flushing tank, with a capacity of 850 gallons, into which the sewage from the main building discharged; a basket screen of wire of 1-in. mesh, removing the larger matters, such as waste paper, rags, lemon and orange peel and the like.

After leaving this tank, the sewage, somewhat staled, was discharged periodically upon a single nitrification bed, in a brick chamber 12 ft. in diameter and 3 ft. in depth, filled with coke, the particles of which were of chestnut size and smaller.

Perforated drains led from beneath this bed to an automatically-controlled valve in a manhole outside of the chamber, so arranged and operated by means of differentiated inlets and a float as to discharge the contents of the bed after it had remained in contact with the coke some 2½ hours. The effluent from the coke bed thence passed onto an artificial sand filter 30 ins. deep, carefully prepared of graded and suitable materials and well underdrained, and proportioned for a rate of flow of 250,000 gallons per acre per day. The object of this arrangement was, that such anaerobic action as might be possible would be set at work in the flush tank, which was made large for this reason; and that the partially broken-down organic matter would be the more readily acted upon in the nitrification bed. Subsequent experience led us to highly value this feature of the design, and extend it. The sand filter was only added as a precautionary measure.

The sewage from the very first was of high concentration, owing to the insufficiency of the water supply—rough determinations showing, free ammonia, 3.40 parts per 100,000; albuminoid ammonia, 0.75; chlorine, 8.00.

Notwithstanding this, bacterial activity was rapidly set up in the nitrification bed, and in two weeks it was at its best, the effluent being bright and odorless, the sand filters evidently having little if any work to do. This condition was maintained all during the early part of the season.

Among the minor practical difficulties which developed was the fact that the sewage would form a membrane over the top of the coke bed. No attention whatever was given to the plant by the attendant of the Club, and if neglected for many weeks this membrane would become water-tight. When this film was broken open the sewage would rush down violently into the coke bed, showing that it was filled with air beneath. So long as the sewage could be got to go down into the coke, it would purify itself readily; and during the entire summer no deposit was to be found at the bottom of the bed—a difficulty which had been feared at the outset.

During the summer the particles of coke each became covered over with a thin film of nitrogenous matter, slightly reducing the liquid capacity of the bed, but evidently increasing bacterial activity. It was estimated that with the average flow of sewage for the summer, not less than 40 cu. yds. of sludge of 90% moisture were entirely consumed in this little space of 340 cu. ft. The purification effected in the early work of the plant was over 95% of organic matter removed.

The Golf Club proved to be more successful than

*Civil and Sanitary Engineers, 127 Hartford Building, Chicago.

had been anticipated. Its membership during the summer and fall doubled and trebled, the main building was enlarged and the quantity of sewage rapidly increased. The plant began to receive quantities of sewage 50 to 100% in excess of that for which it was designed; and it was watched with great interest under these circumstances. The quantity of the effluent somewhat deteriorated. The sand filter did more work. Some fungus growth appeared in the pool immediately below the outlet. No odor was perceptible, and no nuisance could be said to exist, although the purification was reduced to 74% of oxidizable matter removed.

At this time the financial conditions of the Club prevented full and complete chemical and bacteriological examinations from being carried out, but rough determinations, together with the physical appearances, gave an excellent opportunity to judge of the work that was being done.

In the early part of September, when some 4,000 gallons of very concentrated sewage were being purified daily, the bacterial efficiency of both coke and sand bed failed; and the results which followed brought into more prominent light its recent excellent efficiency. Where golfers had previously passed over it and by it in scores every day without observing its proximity, it became so odorous as to make its presence known for several hundred feet around. Steps were promptly taken to temporarily divert the sewage, and the filter was given a rest for about one week. The area of the secondary sand filter was slightly increased and a new form of filling and emptying device for the coke bed was introduced; the original one having proved unreliable through corrosion. Otherwise no change was made in the plant, the coke not even being removed from its bed.

At the end of a week it was in good condition, and sewage was again introduced in gradually increasing quantities. It was noticeable that the coke freed itself from impurities much more rapidly than the sand filter. At the time the plant clogged, the rate of flow through the coke filter was nearly 1,500,000 gallons per acre per day; while the effluent had passed the sand filter at about 500,000 gallons per acre per day; about twice the rate originally intended. In a week or two bacterial activity was re-established, and the filter did good work again, abating all nuisance and giving an excellent effluent, considering the rate of flow.

Just at the end of the Club season, at a period of popular interest, the rate of flow for some days became fully 2,000,000 gallons per acre per day through the coke bed, and about 750,000 gallons per acre per day through the sand bed; under these conditions the plant again became overloaded, the wonder being that it should have operated so long as it did under such high rates.

The results of the season's experience having met our most sanguine expectations, it was determined to increase the capacity of the plant, both to reduce the rate of flow and to meet new demands upon it from an additional building erected in the spring of this year.

Accordingly it was entirely remodeled and enlarged so as to be fully capable of purifying 6,000 gallons of sewage per day. The new plant consisted of a septic tank capable of holding the maximum flow of 24 hours, built of brick, arched and sodded over. The original flush tank was dispensed with and the sewage passed direct to the septic tank without intervening screen or grit chamber. The effluent from the septic tank passed to two square nitrification beds by means of an alternating device which has now worked successfully for six months.

The nitrification beds were of brick, 12 ft. sq., with an effective depth of 3 ft. One was filled with the coke used the previous year, which was found, when removed from its old bed, to be as clean and bright as when it had been deposited there the year before. The other bed was filled with fine cinder about pea size. The rate of flow through the nitrification beds was (intermittently) 500,000 gallons per acre per day, or about 2 cu. ft. of coke to 1 cu. ft. of sewage per day. The alternating device is so regulated that the beds fill in from five to six hours when running at the maximum rate. The beds have seemed to become most effective after a film of nitrogenous matter forms upon the particles of coke. The effluent automatically and alternately discharged onto the sand bed used last year, which, however, was not enlarged at the time the plant was remodeled. The new design seemed to be fully equal to the occasion, and most effective purification resulted even without the use of the sand bed.

A rather curious and singular disaster, however, soon befell it, which caused much trouble and no little study for the time being. After having operated many weeks in a most satisfactory manner, it suddenly began to fail. The most noticeable failure occurred in the effluent from the septic tank, which became opalescent, and the sewage in the nitrification beds rapidly filled with a large amount of black, sooty filiments, denoting decomposition. It was evident that something was wrong, but just what could not be for the moment determined.

A little later there began to appear on the surface of the nitrification beds a lime sludge, which ran over from the septic tanks. Investigation showed that this was nothing less than the calcium carbide ash from a large acetylene gas plant which has recently been installed, and which used 100 lbs. of carbide daily, the saturated residue of which had been daily deposited in the main sewer. It was the most convenient way for the attendant of the acetylene plant to get rid of his own troubles, but it made several weeks of exceeding trouble for others. The ash from the calcium carbide in such quantities has enough lime to completely destroy bacterial activity in the septic tank or nitrification bed, to say nothing of its being a material which is most disastrous to sewers themselves, by choking and filling them with its deposit.

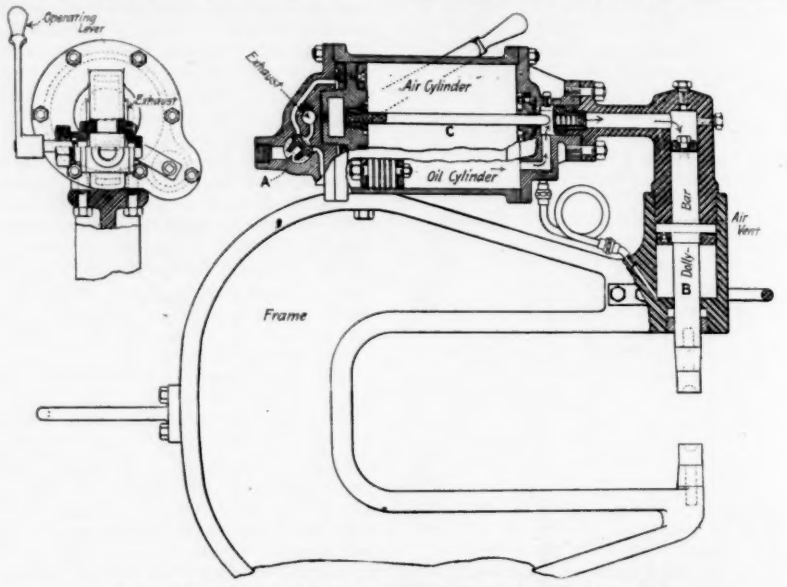
Our general impression of the septic tank and nitrification bed is that they are a success if properly designed and intelligently supervised. There is, however, some doubt as to whether they are as elastic in their capacity to take sudden and considerable increases in flow as land or intermittent filtration methods; but we believe that they are susceptible of great improvement, as experience shall teach the practical difficulties connected with their operation.

One of the difficulties with the septic tank is the rigidity of its design. It is very evident from our own experience that there is a certain point beyond which it is undesirable to have the sewage remain in the septic tank, because, as Dr. Sims Woodhead has shown, certain chemical compounds result which much interfere with the later proper nitrification. For this reason, we believe that the septic tank should be so designed that its capacity can be varied to meet the increasing or varying flow of sewage.

There are also practical difficulties with the nitrification beds which are yet to be overcome. No satisfactory emptying device has yet occurred to us which will completely drain the beds, and yet bring the sewage which fills the lower tile in contact with the coke so that it may be as effectually purified as the remainder of the dose.

After trying three sets of automatic emptying devices, we are satisfied that much yet remains to be done in this direction also. Such a device must be as free from mechanical parts as possible, as anything of this nature in such a location is liable to exceedingly rapid corrosion and destruction; and no matter how correctly designed in theory, will, in practice, soon get out of order.

Chemical and bacteriological records cannot be given at this time. No full record of this kind was made of the first season's work, but the physical conditions were closely observed and recorded. The true test of the plant, however, was in the fact that during 1898 it abated a nuisance with but two brief exceptions, throughout the season, under the most exacting conditions, and when the plant itself was theoretically insufficient in capacity for the work it had to do. It is expected in the coming season to have a chemical record of the work done by the enlarged plant, and later to publish a more full and complete account of it with plans.



THE CASKEY PORTABLE HYDRO-PNEUMATIC RIVETER.
Pedrick & Ayer, Philadelphia, Pa., Manufacturers. Manning, Maxwell & Moore, New York city, Selling Agents.

A HYDRO-PNEUMATIC RIVETER.

We illustrate in the accompanying cut a new power riveter which combines the quick movement of the air riveter and the positive squeeze of the hydraulic machine. The riveter is operated by compressed air; but the pressure is transmitted from the air piston to the dolly bar by a hydraulic mechanism. The operation is such that a rapid movement is given to the bar while setting it upon the rivet and a powerful squeeze is exerted through the short distance necessary to upset the latter. That this operation may be clearly understood, we will describe it in detail. Referring to the cut, the reader will notice the valve A, which is operated by the long lever shown in the end elevation and the air passages leading from it to the large air cylinder, which is provided with an ordinary piston, and the small air and oil cylinder, containing a floating piston. When the valve is turned so that the lap uncovers the part leading to the lower cylinder, the air pressure is admitted directly upon the floating piston and the oil is forced out of the cylinder by the course shown by the long arrow and presses down upon the piston fixed to the end of the dolly bar, B, which is thus rapidly forced down until the die is upon the rivet head. The valve is then moved over in the opposite direction, uncovering the part leading to the upper cylinder, and the piston in the latter is forced forward. The plunger, C, soon enters the bushing

before it, which it fits tightly, and powerfully compresses the oil confined above the piston of the dolly bar, causing the latter to set the die down with great force upon the rivet. The valve is now thrown so as to open the upper cylinder to the exhaust and the air compressed behind the piston quickly forces it back to its original position. The valve is then turned forward to allow the air in the lower cylinder to escape and compressed air is admitted to the annular space surrounding the lower part of the dolly bar, which is thus lifted from the work, and everything is ready to repeat the preceding operations.

The riveter is suspended by a bail, which is arranged so that the machine may be used either in a horizontal or vertical position, and handles are provided to enable the workmen to guide the machine when operating.

For the material from which this description has been prepared we are indebted to the manufacturers, Pedrick and Ayer, Philadelphia, Pa., and to Maxwell, Manning & Moore, New York city, who are the selling agents.

THE EFFECT OF SUBSIDENCE DUE TO COAL-WORKING UPON BRIDGES AND OTHER STRUCTURES.

This is a subject upon which there is comparatively little information to be found in engineering literature. In our issue of May 27, 1897, we published an excellent paper upon this head, written by Mr. John Keay, Inspector of Mines for the State of Illinois, having special reference to the effect of this subsidence upon railway tracks, and we are now able to add to this the following abstract of a paper recently presented to the Institution of Civil Engineers by Mr. Stanley Robert Kay, Assoc. M. Inst. C. E. This engineer has deduced an empirical formula for guidance in cases of this sort from the examples of modern practice falling within his experience of 15 years.

The author first takes up the construction of heavy buildings, bridges, tunnels, etc., over workable coal seams in England, and finds it necessary to study certain conditions and principles before designing such structures. The first is to know the principle of subsidence following the working of the coal, as a guide to position and character of the proposed work; secondly, to have an approximate knowledge of the area of coal to be left unworked, in order to protect a structure over an unworked bed; thirdly, to adapt the design to the possibility of afterwards working out the coal without leaving solid pillars to support the surface.

It is unnecessary to point out that subsidence to some degree always follows coal-working, says Mr. Kay. Generally the subsidence is proportional to the thickness of material removed, and the depth below the surface approximately regulates the duration of the movement. When thick and massive beds of sandstone occur between the coal and the surface, the subsidence is very gradual; and in the case of a thin coal-seam, it is almost imperceptible. In some cases the overlying shale is used for stowing and wall-packing the excavated area, to avoid the expense of bringing the rubbish to the surface; or material is taken underground for this purpose. When this is well done the subsidence is considerably modified, and the surface damage diminished; but it is not practicable in all cases to pack this waste very tightly, and in shallow mines, or those 150 ft. or less below the surface, the overlying strata will occasionally give way quite to the surface. In deeper mines the lines of faults in the rock strata are lines of weakness; and where the coal has been worked off to a fault, damage sometimes occurs to structures upon the surface line of the fault, following its inclination. The author instances a case of this kind where the coal-seam struck the lower side of the fault at a depth of 1,050 ft.; and though the seam was only 3 ft. deep, the subsidence extended to the surface 600 ft. horizontally from the vertical plane at which the fault was encountered.

In an area free from faults, with nearly horizontal strata, the subsidence will be a simple mechanical problem, with few disturbing factors. Then the vertical surface subsidence varies from one-half to two-thirds of the thickness of the material excavated; generally the former where "packing" is resorted to. In a mine 300 ft. deep, the subsidence is generally felt at the surface within a period varying from a few weeks to a few months, according to the depth and thickness of the seam and the character of the overlying strata. Breaks in the strata seldom find their way to the surface from a depth of 300 ft., unless the seam is quite thick and a thick bed of rock intervenes. At this depth complete subsidence will occur in from 2 to 3 years. For deeper workings the author illustrates by a series of levels taken over a 5-year period over two separate collieries 360 ft. and 990 ft. deep respectively. The locality chosen was one with nearly horizontal strata, free from faults of any magnitude, with the average coal-measure overlying strata of alternating "binds" and shales, free from massive beds of rock. The results were as follows: With a 5-ft. coal seam at a depth of 360 ft. the subsidence closely followed the working of the coal; continued for 3½ years and practically amounted to 70% of the thickness excavated. With a 3½-ft. coal-seam 990 ft. below the surface, the subsidence followed the extraction of the coal in about 6 months; continued during 4 years and amounted to 64% of the thickness of coal extracted. In both cases the movement was uniform, without breaking the surface.

In deeper mines the effect of the subsidence is felt more in the nature of a "pull-over" than as an actual downward movement. The strata appear to bend back over the worked part in a curve, with a radius depending on the depth. Owing to this great radius and slow movement there is, as a rule, little damage to surface structures of an ordinary kind. But if the movement of the faces be arrested at any time, as by a sudden stoppage of work, there is a probability that any structure over the line of the working face, or near enough to what will now be an active pull, will in time sustain considerable damage.

The protection of surface structures by leaving pillars in the working seems to be somewhat uncertain. Mr. Kay traced to their sources many cases of damages where it was thought that a sufficient support had been left. He found the subsidence most irregular in action. In some cases the "pull-over" had followed lines of weakness in the natural joints and breaks of the rock until, when it had reached the surface, it had invaded the supposed protected area. In another case, with a 7-ft. seam at 810 ft. depth, there was a bed of rock 60 ft. thick, 150 ft. below the surface. Here the subsidence on each side of the pillar seemed to break the rock and do far more damage than if the coal had been removed entirely, without pillars. In still another case, at a depth of 630 ft. the pillar was worked half way round and left in this condition for some years; when the coal on the other side was then worked out, the "pull" in the opposite direction seemed to break the pillar and damage to the building above followed. On the other hand, absurdly small pillars have proved sufficient, and places where damage was certainly expected have escaped unharmed. These freaks of subsidence, says Mr. Kay, show that no formula can be enunciated that will apply to all cases of support, either as to size or position of these supports. All rules must, therefore, be of an empirical character, and they should be modified or qualified by local considerations.

In the case of subsidence following the working of coal, the extent and time involved have been generally laid down as above, for workings 300 ft. below the surface, and with fairly horizontal beds and no large faults. In other cases, the position and size of faults must be regarded and the direction ascertained at the surface, if the "throw" is of any serious amount. These lines of faults should be avoided, if possible, in locating surface works. If the site be over the working, but near its boundary line, and if the coal is not very deep, full time should be allowed for the final subsidence, and for any break to show itself at the surface. In the case of deeper mines time should be given for the "pull-over" to exhaust itself. The best plan is to avoid such localities, if possible.

As to the area of coal to be left unworked, for protection of surface structures, Mr. Kay says that in horizontal or slightly-inclined mines the theoretical line of break or subsidence is about vertical. In practice this varies on account of the natural lines of weakness in the joints and bedding of the strata, and the movement may vary from the perpendicular to either side. It will be necessary, therefore, in laying out the supporting pillar, to allow for the possible spread of the "pull" during the movement. The strata being horizontal, or nearly so, the pillar will surround the structure equally on all sides.

From an experience of 15 years, and from many examples of modern practice, the author deduces an empirical formula for the best pillar, which he offers as a kind of standard gage, merely requiring modifications to suit the exigencies of the case. It gives the necessary pillar under normal conditions; but it generally gives a sufficient area of support to admit the possibility of "ribbing," or partially working the coal at depths exceeding 900 ft. We quote this formula, as follows:

Let d denote depth in yards; t thickness excavated in feet, and r radius of support in yards; then

$$r = \frac{\sqrt{3\,d \times t^3/t}}{0.8}.$$

For example, an arched bridge over a road or railway requires support. The depth of the seam is, say, 400 yds. The thickness of the material excavated, say, 4 ft., then

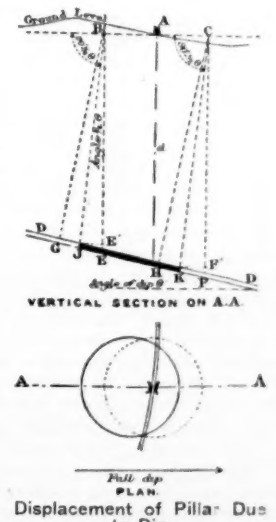
$$r = \frac{\sqrt{3 \times 400 \times 4^3/4}}{0.8} = 68 \text{ yds.};$$

or a pillar of 68 yds. radius left all round the structure will give the support necessary under normal conditions.

When, however, the strata are inclined appreciably from the horizontal, although the size of the pillar, as given by the above formula, is sufficient, its position with regard to the structure it is designed to protect requires consideration. It is often assumed that subsidence under the condition stated takes place at right angles to the dip, as in horizontal mines; and again, that it takes place vertically, as being directly due to gravitation. The author, however, believes that a line midway between the two gives the more general line of break—that is to say, supposing the angle of dip to be θ, then the angle that the line of break makes with the horizon is $90° - \frac{1}{2}\theta$, as shown in the figure.

In laying out upon a plan a pillar for the support of a bridge, to be left in incline seams up to 30°, the size of pillar necessary may be calculated by the formula given. Marking this, upon the plan, round the bridge, the position of the pillar is given supposing the measures to be horizontal. Its lateral displacement to the high side due to the inclination, at a depth d, is $d \tan \frac{1}{2}\theta \cos \theta$. This lateral displacement may be graphically determined as shown in the vertical section on the line of dip.

Let A represent the bridge to be supported by a pillar to be left in the coal DD at a depth of d yards. Calculate the size of the pillar from the formula given, and mark it



Displacement of Pillar Due to Dip.

upon the horizontal line at B and C drawn through the ground-level at A. Draw B J and C K, making an angle of $90° - \frac{1}{2}\theta$ with the horizon from B & C, respectively. Then J E and K F represent the lateral displacement due to the dip in the coal, and J E′ and K F′ the displacement in plan. This is shown in the plan, where the dotted circle represents the position of the pillar when the coal is horizontal, and the circle in a full line its position corrected for dip.

In the case of large pillars at a depth of more than, say, 300 yds., it is frequently found possible to rib them across, or to work half and leave half by means of banks about 20 yds. wide driven through the pillar, as shown. In this manner a considerable saving is effected in the purchase price. The strata appear to arch themselves over the worked portion, and there is practically no subsidence.

Plan of Pillar Partially Worked by Means of 20-yard Banks.

Where several workable seams of coal occur, one over the other, the great expense of purchasing support may offset the cost of possible repairs or a new bridge. In most cases, where the coal is over 900 ft. below the surface, and the bridge superstructure is steel or iron, the coal may be extracted beneath in a regular moving face with little other damage than the lowering of the general level. Tunnels and aqueducts should have support; but in the case of steel superstructure and well-tied abutments, the coal may afterwards be worked out, if the waste is packed as solidly as possible in the area left by the coal extracted. As the surface subsidence will be about two-thirds of the thickness of the seam extracted, this height should be provided for in the original design. Lofty viaducts should be protected by pillars, and the piers should be solid and not pierced by arches.

The paper of Mr. Kay called out a lengthy and interesting discussion from Members of the Institution. Mr. J. A. Staner said that the rule laid down for coal mines would not apply to salt-working in Cheshire, where, instead of 4-ft. to 6-ft. coal seams, the beds of rock salt were 84 and 82 ft. thick, with 30 ft. of marl between. This salt is both mined and pumped out as brine. Cases were mentioned where the ground had subsided 60 to 70 ft. Many of these cones of subsidence seemed to be formed by the cracking of the marl stratum, and the surface water then drew the sand and glacial drift into the cavern below. As to building in such territory, Mr. Staner said that the best type of structure was a wooden or iron frame filled with stucco or brickwork. He showed a photograph of such a building which had turned over through an angle of nearly 45°, and yet was little damaged.

Mr. Tylden Wright, referring to coal mining, remarked that in 1898 over 200,000,000 tons of coal were raised in Great Britain, representing almost 50,000 acres of coal 3 ft. deep. Over this area the subsidence should be about 2 ft. While agreeing generally with Mr. Kay's statements, he did not believe that the wave of subsidence followed the working head. Careful experiments extending over 7 years, and made monthly, convinced him that the subsidence began considerably in advance of the working of the coal. This speaker was called in to advise the owner of Newstead Abbey, in Nottinghamshire, under which ran a coal working. He found that the pillar required to protect this structure would cover at least 40 acres and represent $20,000 in value; such a pillar would also throw the lakes close to the Abbey out of level, and cause much trouble. The 3-ft. coal seam was 1,680 ft. below the surface, but 3 ft. 8 ins. of material had to be removed. After due consideration Mr. Wright took the responsibility of ordering that the pillar be entirely swept out by long-wall work. Observations had been made by Mr. Bagnald Smith, the Managing Director of the Newstead Colliery Co., for 7 years, and these fortunately began before the coal was worked. He found that when the coal working was still 270 ft. from the Abbey area, the latter began to sink at one end at the rate of ⅛-in. per month; as the work advanced the wave of depression increased from ⅛-in. until it ultimately reached 1¼-in. per month. At one time one end of the Abbey was 10 ins. lower than the other. But the fall took place so smoothly and steadily that the tracery of the great west window of the Abbey, 800 years old, did not have a stone loosened, though it subsided in all 23 ins. This was two or three years ago, and the working face is now 1,500 ft. past the Abbey; but there is still a movement of about ⅛-in. per month. But in another case, in the same neighborhood, the strata tilted up instead of settling down steadily, and the house above was somewhat damaged. The speaker advised taking the risk of sweeping all the coal out, rather than leaving pillars for support.

To illustrate the effect of subsidence from coal mining, Mr. Inglis said that in one district the Great Western Railway had to provide about 70,000 cu. yds. annually of filling to make good the depression of its tracks over coal mines. There was also a canal in South Staffordshire which had to be raised in all 20 ft., from a similar cause

Fig. 1.—View of Skeleton Steel Beacon on Pollock Rip Shoals, Cape Cod, Mass. United States Light House Board.

On this same railway the arched masonry behaved well in many cases under subsidence, and in about an equal number of cases it failed. In the case of the Merthyr tunnel, 1½ miles long and with a total settlement of 10 ft., the settlement was progressive, and the chief trouble encountered was the fact that the portion over faults did not settle, and had to be lowered to join the other portions.

Sir Benjamin Baker said that his experience in tunneling led him to recommend pushing all undermining work as rapidly as possible, and thus giving the overlying material no time to flow. He instanced a number of examples in support of this contention; among them the original Chicago tunnel driven through mud, without shield or timbering, and depending only on the rapidity with which the mud was dug out and the 9-ft. hole lined with brick.

METHODS USED IN PLACING THE SKELETON STEEL BEACON COAST SIGNALS.

An experimental skeleton steel beacon, designed by the United States Light House Board, for use in shoal water as day marks and for survey stations, was described in Engineering News for Sept. 30, 1897. The first of these beacons was installed on Pollock Rip Shoal, off Cape Cod, Mass., in September, 1897, and it has since then withstood the storms of two winter seasons without any material damage, thus clearly demonstrating the practicability of this type of marine coast signal. Fig. 1 affords an idea of the appearance of the beacon in position on Pollock Rip Shoals, in

Fig. 3.—Skeleton Beacon Supported by Pontoon Ready for Towing.

a depth of 18 ft. of water at high tide. Ordinarily the beacon ball is about 30 ft. above the surface of the ocean. The steel structure for this first signal was made by the Russel Wheel & Foundry Co., of Detroit, Mich., and was shipped in pieces to Boston, where it was assembled in the navy yard dry-dock and floated on pontoons to its final location. It was then placed by flooding the pontoons. The 4-ft. disks were each provided with a water jet device with the intention of sinking them for about 4 ft. in the sand forming the shoal. Owing to the rough weather prevailing at the time the beacon was placed this was found impossible, and the structure has remained since that time resting on the bottom with apparently a very small and even settlement.

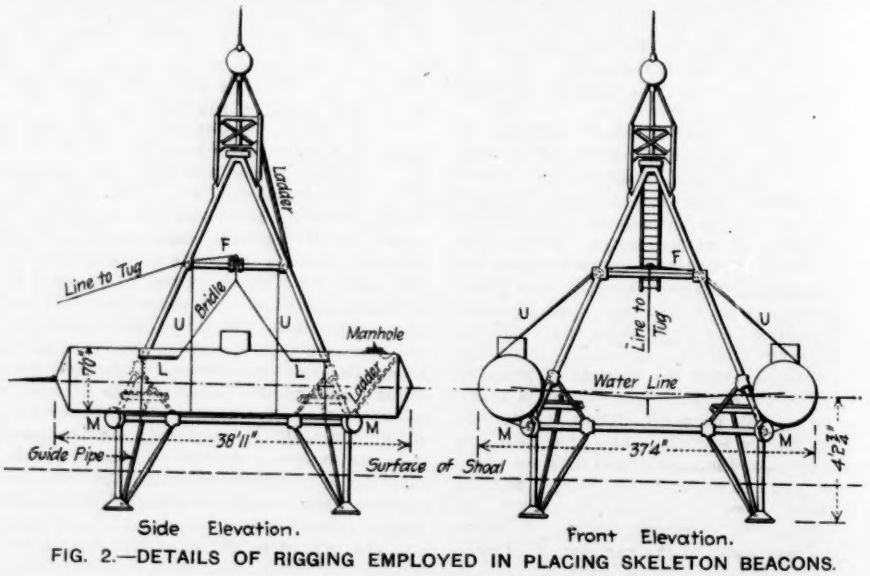


FIG. 2.—DETAILS OF RIGGING EMPLOYED IN PLACING SKELETON BEACONS.

The success attending this experimental signal warranted the placing of others of the same type, and the Light House Board has let contracts for two similar beacons which will, it is understood, be placed on Nantucket Shoals, Mass., and on Sabine Banks, in the Gulf of Mexico. Others will undoubtedly be placed as occasion demands.

In placing these latter beacons steel tank pontoons were employed, as shown in Figs. 2 and 3. These are cylindrical tanks, 38 ft. 11 ins. long and 7 ft. in diameter. Together they weigh 26,000 lbs. and have 6,000 lbs. of ballast inside. As the steel structure weighs 57,100 lbs., the total weight

to be floated amounted to 98,100 lbs. Allowing 63 lbs. of weight per cubic foot of displacement, a total of 1,414 cu. ft. were required, and this was obtained with a draft of 3 ft. 5¾ ins. When secured in position, as shown in Figs. 2 and 3, the total draft was 14 ft. 2¾ ins.

To secure the pontoons to the structure so that they could be released at the same time and the structure allowed to sink evenly, an ingenious system of tie ropes and levers is employed. This arrangement is shown in Fig. 2, in which it will be noticed that each pontoon is provided with four wire rope slings, two long ones (U U) passing around the tank and up over the upper brace, and two short ones (Y Y) looped around the tank and the lower horizontal side bars of the beacon. The slings are provided with turnbuckles for drawing them up tight. It will be seen that the resultant pull of the four slings binds each tank firmly against the heavy inclined members of the beacon. The ends of the short slings are provided with loops which are slipped over binding levers (L L), seen in Fig. 2. The long arms of each pair of levers are attached to a bridle rope, in turn connected to a single rope which passes up and over a small deflecting pulley mounted on a temporary framing (F) on the upper bracing, and loops over a trip pin which also locks the release rope of the other pontoon. A line runs from this trip pin to the tug used to tow the outfit. Upon arriving at the proper location the beacon is swung into position and the line attached to the trip pin is pulled. This releases the levers and opens up the short slings, and thus permits the skeleton to sink on an even base. The temporary portion (F) and the several slings are then removed and the tanks towed back for future use.

For the material from which this description was prepared we are indebted to Major R. L. Hoxie, Corps of Engineers, U. S. A., Engineer Secretary of the Light-House Board.

SWISS LOCOMOTIVE AND CAR WORKS are to be established by European and American capitalists, according to press dispatches. Besides locomotives and cars, it is stated that the works will also build electric cars, switches and signals. The annual capacity of the works will be 600 locomotives, 1,000 steam railway passenger cars, 1,000 electric railway cars, 10,000 switches and signals with electrical motive power. The directors are G. Burnham, of the Baldwin Locomotive Works, Philadelphia, president; S. G. Brill, of Brill & Co., Philadelphia, vice-president; W. Siemens, of Siemens & Halske, Berlin, secretary; De Neuflize, director of the Paris, Lyons & Mediterranean Ry., treasurer, and Cernielle Barbey, general manager of the Yverdan & Ste. Croix Ry., managing director. It is the intention of the directors to equip the works with American machinery. Mr. Angus Sinclair, Editor "Locomotive Engineering," has been directed to advertise for a chief engineer, who will have a year's engagement at $20,000; five assistants, who will be engaged for a year at $6,000 salary; eight locomotive workshop foremen, four carriage-shop foremen and four signal-shop foremen for permanent engagements, with salaries ranging from $2,000 to $5,000 a year. The traveling expenses from America to Switzerland and back will be paid by the company.

AMERICAN LOCOMOTIVES, to the number of 20, have been ordered for the Saxon State railways, at 54,760 marks, or $13,142.40 each, according to press accounts. The engines are compound, and are being built by the Baldwin Locomotive Works. A Breslau firm is said to have offered to build these engines for 54,540 marks each, but it required a much longer time for delivery.

THE USE OF STEEL TIES for experimental purposes on the New York Central R. R. has not given very satisfactory results. This road has at Garrison's, N. Y., about 1,576 ft. of stone-ballasted track laid with 721 of Hartford's steel ties which have now been in use ten years. We are informed that these ties have proved durable, but require much work to keep in surface, probably twice as much as wooden ties. They are hard to line, the ballast shakes away from them, and they give a rattling sound from the stone ballast and from the bolts. This road also laid, at 110th St., New York city, about 3,375 ft. of track with 1,350 steel ties weighing 86 lbs. each, made by the Schoen Mfg. Co., of Pittsburg, Pa. These ties, which were described in our columns some time ago, have been in service several years, but are said to have proved so unsatisfactory that they are now being removed and replaced with oak ties. These steel ties are much less satisfactory than those in use at Garrison's, the reasons given being that their shape prevents the economical lining of track, they break much more readily in the middle, and they crush under the rail base. According to European practice, these ties are too light for use in main track under heavy traffic.

THE NEW EAST RIVER BRIDGE may cost $2,000,000 more than the original estimates, owing to the rapid increase in the price of steel and steel wire. The principal contract, that for the main span, has still to be let. The holding up of the bridge bond issue, for one year, by the Municipal Assembly, is an indirect cause of at least a part of this advance.

THE WELLMAN POLAR EXPEDITION to Franz Josef Land returned to Tromsoe, Norway, on Aug. 17. This expedition, commanded by Mr. Walter Wellman, started from Tromsoe, on June 26, 1898, to explore the north and northeast portions of Franz Josef Land, and to reach the pole itself, if possible. It reached Elmwood, the headquarters of the Jackson Expedition on July 28; and the expedition then started for Cape Tegethoff, reaching that point on July 30, and they there established headquarters. Lieut. E. B. Baldwin, of the U. S. Weather Bureau, reached Cape Heller, in Lat. 81°, on Sept. 21, and returned to Cape Tegethoff on Oct. 30, leaving two men at Cape Heller. On Feb. 18, 1899, Wellman and three men started for Cape Heller, and found that one of the two men left there had died; on March 20 the party reached Lat. 82° North; but here Mr. Wellman's leg was sprained by a fall into an ice crevice, and he was compelled to return, having reached a point 25 miles northwest of Freedere Island, where Dr. Nansen landed in 1895. This expedition charted the unexplored east coast and discovered a new large, ice-covered island extending to Long. 64° East, they named it Graham Bell Land. A fairly complete map of the archipelago was made by Mr. Wellman, who was largely assisted in this work by Mr. A. Harlan, of the U. S. Coast Survey.

BAROMETRIC READINGS reduced to true atmospheric pressure are required by the U. S. Weather Bureau. By instructions No. 92, 1898, the Bureau required that on and after Jan. 1, 1899, the approximate correction for gravity shall be applied to all barometric readings. This order is in accordance with the recommendations of the various international congresses; and is the more important now to the United States since the recent extension of the Weather Bureau service to territory extending from 10° to 55° north latitude. This correction applies to all mercurial barometers, and is nearly constant at any one station. It is given in the form of a table in Circular F, Instrument Division, which will be furnished on application. The complete observations as then returned, for example, would read as follows:

Attached thermometer 76.5°; observed barometer reading	30.287
Correction for temperature	—0.131
Correction for gravity, instrumental error and capillarity	—0.066
Total correction	—0.197
Corrected reading	30.090

This corrected reading is a standard measure of atmospheric pressure, and is perfectly comparable with similar corrected readings made at any place in the world.

TREE PLANTING BY FARMERS is being encouraged in a practical way by the Division of Forestry of the United States Department of Agriculture. A circular has recently been issued stating that the Division is prepared, as far as a limited appropriation will permit, to render practical and personal assistance to farmers and others by co-operating with them to establish forest plantations, wood lots, shelter belts and wind breaks. An expert tree planter has been placed in charge of a section of the Division which has been organized for this work, and he will be assisted by collaborators in the different states who are familiar with local conditions. It is proposed that visits be made by the superintendent of tree planting or his assistants to the lands of farmers desiring aid in forestry, and that working plans be given, including help in the selection of trees, information about planting, and instruction in handling forest trees after they are planted. Copies of the circular may be obtained by those interested in the subject on application to the Bureau of Forestry, Department of Agriculture, Washington, D. C.

THE PRIZE FOR AN IMPROVED GARBAGE and refuse wagon, or "dust cart," offered some time ago by the London County Council, has been awarded to M. Glover & Sons, of Warwick. There were 325 competitors. The accepted design has four sliding covers with wind guards raised 8 ins. above them; it also has a tipping screw.

A STEEL APRON CONVEYOR has been put in operation at the refuse disposal plant, Boston, Mass., for handling the sweeping and general street refuse, consisting of rags, bones, paper, etc., which it delivers to the furnace. The material is sorted over by pickers at each side of the conveyor, and all articles which cannot be burned or which possess value for other purposes, are taken out. The conveyor is about 100 ft. long, elevated on a steel framework to a sufficient height for delivery to the furnace. It consists of two strands of roller chain, to which are fastened double-beaded or corrugated steel plates, forming an endless apron. The corrugations of the plates overlap so as to make a practically tight joint. It passes two curves, and the rollers in the chains (occurring at every link) enable the chains to accommodate themselves to comparatively sharp curves without the assistance of sprocket wheels or idlers. The conveyor was built by the Jeffrey Mfg. Co., of Columbus, O.

COKE-BURNING LOCOMOTIVES ON THE BOSTON & MAINE R. R.

An interesting departure from ordinary practice in regard to locomotive fuel has been made this year by the Boston & Maine R. R., in adopting the use of coke instead of coal as fuel for its passenger engines, and probably eventually for its freight engines. This road carries an enormous passenger traffic, and in order to prevent the discomforts incident to dust from the ballast and smoke and cinders from the engines, the management has adopted the policy of sprinkling the ballast with oil (a practice now followed by a number of roads) and of using coke fuel on the engines. An incidental advantage of this fuel is the prevention of fires now caused by sparks from the engines, and it is said that this saving is estimated at about $100,000 per year. This is certainly an important saving, if the estimate is correct.

The coke is obtained from the New England Gas & Coke Co., and is not more expensive than coal, since it is only a by-product of that company's plant. It is burned successfully in the ordinary fireboxes, and firing is required only at long intervals. The tenders have their sides raised, so that they can carry fuel enough for runs of the usual length. In answer to enquiries respecting the use of coke fuel, we have received the following reply from Mr. Henry Bartlett, Superintendent of Motive Power of the Boston & Maine R. R.:

We have now about 100 locomotives in passenger and shifting service using coke. When we first started to experiment with coke, we found difficulty in burning it satisfactorily on the cast-iron finger grate, and therefore equipped several locomotives with water grates. Since that time, on further experimenting, we have been able to accomplish the satisfactory burning of coke on the cast-iron grates. We now find that to introduce coke on an engine, no change is necessary except the enlargement of the exhaust nozzles. This we are able to do materially, with equal steaming effects; thereby getting, of course, better service. The enginemen and firemen have all been instructed verbally, and we have no written instructions regarding the use of this fuel.

On our passenger trains having the longest runs, it is our practice to fill the firebox up to the fire door and not fire until steam is shut off again. In so doing, we are able to run 10 or 15 miles without touching the fire. On our trains making frequent stops, and on our shifting engines, that do not carry such a heavy fire, we fire more frequently. Coke, the same as anthracite coal, does better in firing when the draft is off.

The coke costs us about the same as coal, and we burn no more of it in doing the same work, in fact, a little less; and we find it fully as efficient as coal in evaporative qualities. On the whole, coke seems to us to be the most promising fuel of any kind that we have ever used; and to be the best solution of the smoke and dirt problem of anything yet tried.

THE USE OF FINE IRON ORE OBTAINED BY CONCENTRATING PROCESSES.*

By Professor J. Wiborgh, Stockholm. Translated by H. Bauerman, F. G. S.

By the introduction of magnetic and other methods of separation, the power of enriching or improving iron ores, by the removal of barren or undesirable constituents, has been greatly increased; and by the use of such methods the waste in working, in the case of magnetic minerals at least, can be considerably diminished. The advantage arising from such operations is, however, largely qualified by the circumstance that the product or concentrate is usually obtained as a comparatively fine powder, which limits its utility to the smelter when compared with that of similar or even poorer ores obtained in larger masses, and therefore the question of how such material can best be applied is now becoming of importance. As a contribution to the knowledge of the subject, the present paper, giving the views of one of the most experienced Swedish iron chemists, cannot fail to be of interest to the members of the Institute.

Powdered iron ores obtained by concentration may be utilized in several different ways, namely—

I.—By direct addition to the charges in the blast-furnace.
II.—By agglomeration previously to charging in the blast-furnace.

*A paper read before the Iron and Steel Institute of Great Britain.

III.—As a refining or softening material in the open-hearth furnace.

IV.—For the production of sponge iron for use in the open-hearth furnace; which uses will be considered in the above order.

I.—Direct Use in the Blast-Furnace.

The proportion of small ore that can be used in the blast-furnace is subject to variation according to the conditions of fuel and working, but cannot, in most instances, be very large, limits being imposed by the tendency of the material, especially if it is of high density, such as pulverized magnetite, to overrun the fuel charge and come down to the tuyeres in an imperfectly reduced condition, as well as to form accretions or scaffolds, by adhesion to the furnace walls above the earth.

It appears that in the smelting of rich and heavy concentrates, the coal should be used in smaller pieces than is necessary with finer materials of a less dense character, such as lake and bog ores, purple ore, etc. This combination can, however, only be successfully handled in furnaces of small height, as in a tall furnace the close packing of the charge is necessarily attended with slow driving and unduly large production of carbon monoxide, from the prolonged contact of the gas from the reducing zone with the fuel above.

Irregularity due to Adhesion of Ore to Stack Wall or Scaffolding.—It is a matter of general experience that finely-divided ore and ore dust readily adhere to the heated wall of the furnace, and gradually accumulate into large masses, which, falling into the region of the hearth when detached by the pressure of the column of materials above them, meet with an insufficient body of fuel to effect their complete fusion, with the result of producing "cold" iron or choking. This tendency to form accretions or scaffolds is the principal cause restricting the use of powdered ore in large quantity in blast-furnaces, but there are certain distinctions to be made; thus the tendency to scaffolding is greater with small than with large ore, with small-grained ores of equal size it is greater with those of lower than higher density, and with those containing fusible minerals greater than with those carrying waste constituents of a refractory character. Other conditions influencing the result are the greater or less steepness of the bosh walls and the more or less refractory character of the materials used in the stack lining. In a furnace at Vidlitz, Russia, the slope of the boshes above the tuyeres was 75°, which at a higher level was reduced to 70°, a section which would a priori be considered as extremely unsuitable for the use of powdered ore. Nevertheless the furnace worked satisfactorily even on concentrates alone, so long as cold blast was used. When, however, the blast was heated to 450° or 500° C., scaffolding began, and continued with little alteration until the hearth and tuyeres were burnt out, and no improvement was experienced even by reducing the proportion of concentrate in the charge to 30%. The difficulty was attributed to the intense local heating of the hearth and boshes by the blast, causing the finely-divided ore to stick to the wall of the furnace, but it was considered that the fine dust of the bog ore was a greater source of trouble than the dense magnetite.

As a preventive of scaffolding with the materials under consideration, furnaces with cylindrical stacks or a bosh angle of 90° have been suggested, but it is easy to see that the use of such a section would be attended with considerable difficulties. Notably the furnace must either be of small dimensions, or, if of a large capacity, it would be unreasonably wide, and the rapid driving necessitated by such a form would be suitable to the production of pig iron for forge use, or the production of malleable castings rather than a more siliceous or manganiferous metal; and even though magnetic concentrates may be somewhat more easily reducible than similar ores in lump form, it is doubtful whether it could be advantageously used under the conditions of forced driving called for by the cylindrical form of stack.

Rich and heavy concentrates or small ores have, however, been used without difficulty on several occasions; as, for example, at the old works of Hogfors, where concentrates obtained by washing from the leaner ore of Norberg were used to the extent of 30%, and at the Bagga furnace of 25%, the latter being obtained by magnetic separation with the Gromdahl separator. Certain ores from Grangesberg, when crushed after roasting, also readily fell to pieces, but no great inconvenience has been experienced in them. The author is, therefore, disposed to consider that the addition of concentrates up to about 50% of the charge may be regularly carried out in furnaces with a bosh angle of 83 to 84 degrees. The washing of powdered ore with a view to increasing its reducibility is of less consequence than with the same ore in lumps, except, of course, when it contains sulphur when it becomes necessary. At Bagga the concentrates are roasted in a small reverberatory furnace. Another inconvenience attending the use of powdered ore is the loss caused by dust in the gases, and in this respect the cylindrical stack would be most disadvantageous on account of the velocity of the upward current in the stack, which would necessarily be greater than in a furnace of smaller bosh diamter. At Vidlitz, when the charge consisted of magnetic concentrates and bog ore only, from 8 to 10% of the powdered ore was carried over into the gas conduits.

II.—Agglomeration Before Smelting in the Blast-Furnace.

In order to avoid the inconveniences attending the use of small ore in the blast-furnace, numerous methods have been proposed and tried, more or less successfully, for consolidating it into coherent masses or lumps as a preliminary to smelting. This may, in certain cases, be done without the addition of foreign matter, but, as a general rule, some binding material is required. There is a tolerably wide range of choice among the substances that can be used for this purpose. One condition, however, is necessary, namely, that nothing shall be used that would be injuriuos either to the product or detrimental to the working of the furnace, which excludes such a substance as gypsum, as likely to introduce sulphur into the iron, or magnesium chloride, which, by bringing chlorine or hydrochloric acid into the blast-furnace gas, would be destructive to the iron work of the stoves and boilers.

The principal methods that have been practically tried are as follows:

Agglomeration by Heat Alone Without Binding Material.—Powdered ores that are not particularly rich and contain easily fusible silicates, such as hornblende or pyroxenic minerals, may be made to cohere by heating in a reverberatory furnace up to the point necessary to produce incipient fusion of these accessory minerals; but to obtain a similar result with rich magnetic concentrates, it would be necessary first to mix them with such a material; as, for instance, with easily fusible blast-furnace slag. Such methods are, however, costly, as the temperature to which the mixture must be heated is higher, and the time required is longer, than is necessary in the ordinary method of ore calcining. They have been used at the Cornelia mine at Stollberg, and at Valimaki in Finland. The powdered ore is mixed with water, and the damp mass is molded into bricks, which, when dried, are sufficiently coherent to be charged into kilns and burn to masses of considerable strength and hardness. The best results are obtained when the ore, which should be in a very fine powder, is not very rich, containing 50 or at most 60% of iron, the remainder being fusible silicates. This has also been tried experimentally at Vidlitz, the mixture being molded into small cylindrical masses, which are burnt with charcoal dust in the Schedinska kiln, which is generally used in the locality for calcining iron ores. At Stollberg the finely-powdered ore obtained by washing was molded into bricks and subsequently burnt.

Consolidation of Small Ore with Lime.—Caustic or slaked lime tempered to a stiff paste with water is the best binding material for powdered iron ores, especially for those containing a notable amount of iron silicates or silica. Briquettes made with such materials become harder by continued exposure to the air, first by the conversion of the lime into carbonate and subsequently into silicate, and the intimate mixture of the reducing and fluxing material in the mass tends to facilitate working in the blast-furnace. For this latter reason, in the treatment of differently reducible silicates, such as heating furnace slags, it is sometimes found convenient to grind them to powder and mix them with lime and some charcoal dust into briquettes, in order to furnish a slag suitable for smelting in the blast-furnace.

Agglomeration of Ore with Carbonaceous Material and Coking.—It has long been known that pulverulent materials, when mixed with tar, pitch or bituminous coal and strongly heated, give, when cooled, hard and compact masses. This was applied by Weismann about ten years ago in the production of so-called ore coke, which was made by mixing powdered ore with 20% of coal dust and 5% of pitch, pressing the mixture into blocks, which were coked at a strong heat applied slowly. This, however, proved to be too expensive for practical use, but the idea has been revived in a simpler form, namely, mixing small coal and powdered ore together, and coking the mixture in the ordinary way. Experiments in this direction, made at the suggestion of Mr. Carl Ericsson, by Mr. C. C. Dalerus at the Islinge coke works with the concentrated magnetite, obtained at the Lulea apatite separating works, have given remarkably good results. The powdered ore, averaging about 1 millimeter in the size of the grains and containing about 70% of iron, when mixed with 30 to 40% of coal, gave a product which was hard and compact, and could be quenched with water in the same way as ordinary coke of good quality. By coking, the ore was reduced to ferrous oxide with some metallic iron, and showed no great tendency to pass into a higher state of oxidation even when exposed to the air for a considerable time. With easily reducible ores, however, it is probable that there would be a larger production of metallic iron which would readily oxidize when quenched with water, or by long exposure to the atmosphere, with the result of diminishing the strength of the coke.

The author is, however, favorably impressed with the results of the experiments made in Germany upon ore coking, owing to the simplicity of the method, and has considered the subject from the thermo-chemical point of view, in order to determine the possible heat requirements of the process.

The unit of magnetite contains iron 0.7242 and oxygen 0.2758, and as the unit of oxygen in the conversion of iron to magnetite develops 4326 cals., the heat absorption in the reduction of a unit of magnetite to metallic iron will be $4326.0.2758 = 1194$ cals.; while the reduction, if effected with carbon, will consume $^1/_{16}$ $0.2758 = 0.207$ of carbon, producing $^{28}/_{16}$ $0.2758 = 0.482$ of carbon monoxide, and developing $2473.0.207 = 512$ cals., or a heat deficiency of $1194 - 512 = 682$ cals. The carbon monoxide produced is, however, susceptible when burnt of developing $2403.0.482 = 1158$ cals., so that the final result will be $1158 - 682 = 476$ cals. available for heating the flues and walls of the oven per unit of magnetite reduced. These, however, are extreme figures, as they suppose complete reduction of the ore, which is not likely, the temperature prevailing in coke-ovens not being sufficiently high; but any degree of reduction will be attended with some loss of fixed carbon, which, however, it may be supposed, will be compensated by a diminished consumption of fuel in the blast-furnace; but, as far as the author knows, no actual smelting trials of such ore coke have been made up to the present.

Among the causes likely to produce irregularities in working may be mentioned the difficulty of so mixing the ore and coal as to ensure a product of uniform richness; the probability that such mixtures would contract less than coal alone in coking, so that there might be trouble in drawing the charge, and the scorifying effect of the ore dust upon the heated brickwork of the oven; while in the smelting furnace the possibility of such coke coming down the tuyeres unchanged with a partial combustion of the contained iron as well as of the carbon has to be considered. But, as has been before stated, experimental evidence upon such points is entirely wanting.

III.—Use of Powdered Ore in the Open-Hearth Furnace.

Expernments on the substitution of powdered for lump ore in the open-hearth furnace were made by Dr. H. Tholander in the basic open-hearth furnace at Hofors in September, 1897. The material used was the concentrated ore from the Lulea magnetic separating works, which contains 72% of iron and 0.1% phosphorus; the average size of the grains being about 1 millimeter. Four successive charges were made, the first three with pig iron, scrap and ore concentrate, which was worked in the same manner as those with the Kungsguvfa lump ore currently used; while in the fourth, pig iron and ore concentrate alone with some limestone were used, the final additions of ferro-manganese and ferro-silicon being made in the usual way. The final charge consisted of 11.1 tons of pig iron, and 1.22 tons of ore concentrate, which quantity of metal should, according to previous experience, have yielded about 92% of its weight in ingots, or 10.212 tons as a maximum. The actual weight obtained was, however, 10.874 tons, showing an excess of 0.662 ton, recovered from the 1.212 tons of ore added, corresponding to a reduction of 57 out of the 72 units, or a utilization of 75% of the iron contained in the ore. The time required for working this charge was about one-half more than when scrap was used; but Dr. Tholander considers that, with longer experience of the method, this might be probably reduced, and also that it would be possible to increase the amount of ore used from 11 to 15% of the weight of the pig iron.

The composition of the ingots was as follows:

Carbon	0.12 per cent.
Manganese	0.33 "
Phosphorus	0.27 "
Sulphur	0.003 "

Another application, due to Mr. H. Brinell, is an improvement on Ellershausen's process of incorporating the ore with the pig metal at the moment of casting. An ingot mold is partly filled with fluid metal from a ladle, and when it is about to solidify, a quantity of small ore is thrown upon the surface, and this is repeated until the mold is full. From 12 to 15% of ore can be added without notably diminishing the cohesion of the ingots which are to be used instead of pig iron in the open-hearth furnace charge. Rich and heavy concentrates are admirably suited for this use.

IV.—Direct Reduction of Pulverulent Ores.

As it is possible to obtain concentrated ore containing more than 70% of iron, and practically free from earthy waste, it seems to be an unnecessarily circuitous proceeding to convert it first into pig iron when soft iron or steel is required, such material being especially well suited for direct reduction to sponge iron capable of replacing scrap in the open-hearth furnace. For this purpose the author has designed a special furnace, consisting of a heating chamber, in which the powdered ore supplied from a storage hopper, B, is brought up to a high temperature by the spent flame, and a reducing hearth with a hopper for supplying charcoal-dust. The heating is done, partly by producer or water-gas, from an outside supply, and partly by the combustion of the carbon monoxide resulting from the reduction of the ore by charcoal. The substructure contains a system of regenerator pipes. A capacious sheet-iron reservoir is provided for cooling the reduced iron out of contact with the air. The reduced material, which is only very slowly changed by exposure to the atmosphere, consists of a mixture of iron and charcoal powder, which can be removed by an air blast or a magnetic separator. For use in the open-hearth furnace it may be packed into cast or sheet-iron cases, or compacted by pressure into masses to take the place of scrap in the charge.